LAND INFORMATION SYSTEMS AND THE POLICY PROCESS

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It does not take long in terms of human history to devise a tool that soon becomes widespread. What takes time is learning the different contexts into which that tool can be fitted.

Jerome S Bruner

This thesis contains no material which has been accepted for the award of any other degree or diploma in any tertiary institution and that, to the best of my knowledge and belief, the thesis contains no material previously published or written by another person, except when due reference is made in the text of the thesis.

ABSTRACT

There is a commonly held belief in the land information systems community that there is a strong causal link between the availability of reliable, consistent information and effective decision making processes; that the quality of this information bears directly on the quality of decision making and that the application of land information system based techniques to the policy process effecting the planning and management of land is superior, and somehow more proper than the normal social and political processes used to resolve such issues.

These assumptions are questioned. The thesis suggests that there is little evidence to support these beliefs, that the benefits land information systems are delivering at the administrative and management levels are not extendable, except marginally, to the public decision making arena. It moves on to show that the structure and functionality of land information systems will need to be extensively modified and extended if these systems are to make a contribution to the policy process, as the land information system community believes it should.

To defend this thesis, both land information systems and the policy and problem solving processes are examined from an information utilisation perspective. Firstly, the structure and operation of land information systems are reviewed in this light, as is the origin of the link between these systems and the planning and policy processes. Having established this nexus, the problem solving, decision making and public policy processes are examined for how formal, structured information of the type provided by land information system does, or could, interact with these processes. From this analysis, and the research findings from the knowledge utilisation field, it is concluded that land information systems will need to place its data into an extended contextual and value frameworks, introduce different data quality standards, and restructure its systems and functionality in a way that facilitates learning and understanding as opposed to decision making. How this may be achieved, and what role land information systems could reasonably expect to play in the policy process completes the thesis.

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CHAPTER 1

INTRODUCTION

Ours is a world in which perceptions count more than facts
Evelyn Waugh

Introduction

In the world of the land information and geographical information systems there is a presumption that the information emanating from these systems will assist in management and planning of our land resource. Specifically this community asserts that the application of the technology will yield positive benefits for society's well-being through the making of improved, more informed, or in short, better decisions about land related issues.

Statements of this type have been linked to land and geographical information systems from their inception in the mid-1960s. The connection between the systems and better planning is all but taken to be axiomatic, hardly questioned or qualified. This is a faith that will be tested over the forthcoming decade as systems mature, extend beyond their mono-purpose beginnings, and combine to form integrated resources of information capable of being utilised for a multiplicity of tasks. In this environment how much the availability or unavailability of information from these systems influence the public policy process concerning land and land-related activities may become assessable.

Meanwhile, given the developments in land information systems to date, and the record of information systems in public decision making in general, it seems timely to investigate in the context of land information systems statements like that made by Dale and McLaughlin [1988:2][1] "the value of the information and the effectiveness of the decision making process are directly related to the quality of the information and the manner in which it is made available". The purpose of this study in part is to test this proposition, to identify whether the ready availability of formal, structured information about land is of value in land-related policy

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[1]Citation convention: For books and reports, date and page numbers are provided in the text. When referring to the whole book or to journal and conference articles, date only is given.

and problem solving processes, and, if so, what its nature, context and extent should be.

Background to Study

Land information systems and geographic information systems are not new. They have been with us ever since man ended his nomadic ways and developed a need to manage the orderly distribution and use of his most basic resource, the land. Information to support this activity has been collected over the centuries in the form of individual records, transactions, inventories of natural and man-made features and summaries of land use for administrative, planning and management purposes in the fiscal, legal, social and political domains. What has changed over the last three decades or so is the growing belief that the traditional means of holding and organising this data is now inadequate for the needs of the day.

These needs are perceived to be essentially of two types - more effective planning and more efficient information management.

MORE EFFECTIVE PLANNING

This need stems from a belief that the problems besetting society in general, and our land in particular, are becoming more complex and more intractable, and are largely out of control. It is thought that the way to manage this complexity is by more, and more effective planning through the provision of consistent, integrated and complete information, amongst other things, about land. Thus, as one planner writes,

> because of the wide variety of urgent problems in the world (from global to local), there is a need for a coherent framework for information systems, as almost all technological, socioeconomic, spatial, and environmental processes developed together. The provision of reliable, manageable, and up-to-date information, structured according to sound methodology, is essential in order to understand and to influence such processes in a rational and systematic way
>
> [Nijkamp 1984:5].

Similar needs are reported from other land and land-related activities ranging from, for example, the management of water and sewerage services [Cox 1984], or geo-coded economics, social statistics [Martin 1991], to assessing impacts of retail development [Roy & Anderson 1988], and in the local government arena [Romer 1985].

In each instance there is a means–end inference linking the availability of reliable, consistent data with more effective planning, thus leading to greater understanding and control of society's land management problems. So a key element is perceived to be information – information delivered by improved information-management practices through the application of a land information system. The following quotation illustrates the point.

> EPA [Environmental Protection Agency] and other agencies with natural resource management and protection responsibilities are currently facing priority setting and management decisions whose complexity fairly boggles the mind...[but] luckily for us, two tools have recently entered the scene which will allow us to engage in some consistent and comprehensive environmental resource management. The first, the geographic information system, is a new tool which will allow us to better manage and spatially relate disparate sets of data.
>
> [Amsden 1988]

Statements of this kind have led the land information management community to conclude that "the gradual introduction of formal, systematic planning techniques has focussed attention on the need for new strategies and procedures for gathering, administering, analysing and disseminating land-related information" [Dale & McLaughlin 1988:14]. National bodies, like the Australian Land Information Council (ALIC), established in 1986 by the Prime Minister and Heads of State and Territory Government, endorse this apparent link between improved information management and public decision making. Thus, in its national strategy on land information management, ALIC states:

> In an era which demands increasingly more information for more efficient planning and decision making, it has become apparent that better systems for handling land information are vitally important.
>
> [ALIC 1990:1]

The land information systems community therefore sees a direct link between the availability of organised, reliable information on the one hand and more efficient and effective planning and decision making processes affecting land on the other. This study questions this belief and aims to demonstrate that this posited connection between land information systems and planning or decision making does not hold true for, and does not apply to, all types of planning, nor does it extend to the public policy process. By and large, proponents of land information have failed to recognise or acknowledge such a caveat.

MORE EFFICIENT INFORMATION MANAGEMENT

The second reason for questioning the efficacy of traditional land information management practices has its origins in the perceived need to improve the administrative effectiveness of public land record keeping. More efficient recording methods are being sought to reduce cost, increase revenue returns and minimise delays. More effective methods are deemed necessary to make information more accessible, consistent and reliable – to improve "the land information service". The NSW State Land Information Council, for instance, has the aims of:

> 1. Achieving administrative efficiency and cost reduction through minimising duplication, encouraging standardisation, etc.
>
> 2. Generating increased government revenue by a more comprehensive coverage of ownership and tax liability.
>
> 3. Improving the service to the state as a corporate entity.
>
> 4. Providing better service to the public needing data for planning.
>
> [Alexander & Hart 1987]

The key elements in providing these improvements are seen to be the elimination of data duplication and inconsistencies through the building of a land information infrastructure [Anderson 1989] to act "as a concentrator and disseminator of information to others" [Humphries 1984]. By viewing this concentration of data as an information resource, government, it is hoped, will take a corporate view of the problem of land information management, not only for administrative gains but as an information resource for policy formulation and decision making. Even though the drive towards more efficient land information was and is a goal in its own right, the justification for these changes was in most instances also linked to the earlier goal of enhancing the planning process by providing more effectively organised data. A statement by the U.S. National Academy of Sciences Research Council in their report on the need for a multipurpose cadastre (i.e. land information system) typifies this approach:

> there is a critical need for a better land information system in the United States to improve land-conveyance procedures, furnish a basis for equitable taxation, and provide much-needed information for resource management and environmental planning.
>
> [NRC 1980:1]

Administrative reform of the land records system is thus tied to the notion of improved planning and decision making, as exemplified by such pronouncements as "All the information necessary for efficient planning exists but is largely inaccessible" [Humphries 1984]. I suggest, however, that to a large extent the land information systems community is confusing or failing to separate these functions – administrative efficiency and the information requirements of the policy and planning processes. As a result, the benefits of land information systems usage in administration tend to be carried over, being ascribed to the public policy process in the minds of many land information system practitioners. While it is perhaps correct to assign these benefits to some planning exercises and some kinds of policy decision (as noted earlier), land information system proponents have in the main not been so discerning.

Differentiating Land Information System Benefits

There are two apparent reasons why the land information systems community have blurred the distinction between administrative and policy process and the information requirements of each. Firstly, given the rapid growth of land information systems, differentiation has been all but unnecessary since once systems are approved and operational, their results are rarely assessed (Appendix C5). Secondly, because land information systems have been adopted for a wide range of tasks, they take on the appearance of having almost universal utility – a ubiquitous tool for solving land-related problems.

These propositions are discussed more fully below.

GROWTH OF LAND INFORMATION SYSTEMS

The rate of growth in the number, use and applications of land and geographic information systems has been nothing short of dramatic in the last decade. Systems are being implemented at all levels of government by a wide range of agencies and for a multiplicity of purposes. By way of example, the House of Commons report into the handling of geographic information in the United Kingdom [Chorley 1987] says "that as an aid to decision taking and resource management, geographic information is used by public and private sector organisations in a wide range of applications." The report then goes on to identify these applications which have been summarised in Table 1.1. Similar listings of applications may be found in Huxhold [1991] and Forrest [1990].

Table 1.1
Use and Users of Land Information Systems
[Compiled from Chorley 1987:20-30]

Application	User	Data	Uses
Environmental monitoring	Central government, research institutions, water authorities	River water quality, national pollutant emissions, climatological and rainfall. Erosion and sedimentation.	Monitoring and modelling of long-term environmental change.
Land use and rural resource management	Central government	Soil surveys, land capability, land use, land use change, farming activities, forest inventories, landscape	Regulatory, monitoring and planning of land use for agriculture, forestry, conservation and recreation. Integrated planning and resource management.
Epidemiology	Central and local government	Health statistics linked to other data sets	Variation in health by locality, decease incident rates.correlation with environmental factors
Property development and investment	Private sector Planning authorities	Site specific and locale data on land available, building details, ownership, market and valuation, rents, use, zoning	Financial investment; property development. Development of property and investment data bases.
Marketing and business location	Private sector	Socio-economic, demographic and household data on small area basis	Location of retailing, offices, and manufacturing. Target promotions, route scheduling, distribution planning.
Mineral exploitation	Exploration companies	Geological, geophysical and seismic records. Environmental data. Hydro carbon potential. Marine geology.	Oil, gas, mineral exploration on and off shore. Modelling.

Table 1.1 (continued)

Application	User	Data	Uses
Transport network management	Government and private sectors	Location and description of network facilities, usage levels (traffic flow), socio-economic and land use. Maintenance and construction data.	Provision and maintenance of road, rail, canal and pipe transportation networks. Monitoring usage, forecast modelling. Maintenance schedules. Route optimisation.
Civil engineering	Construction authorities Consultants	Surface properties, construction material. Geological, soil and mining records, borehole logs, mines.	Multivariate statistical, spatial analysis and simulation modelling. Site conditions for building, road and dam construction.
Utility network management	Utility authorities	Location and description of plant items associated with gas, water, electricity and telecommunication networks	Inventory, management (maintenance), planning of facilities, networks, customer and billing records
Defence and security systems	Central and local authorities	Infrastructure (street networks, water supply, toxic materials), topographic and navigation	Command and control for defence and civil security (fire, flood, police)
Planning and management of public services	Central government Local government	Population census, employment, transport, socio-economic, land and property information	Local government grants, inner city redevelopment Monitoring and forecasting changes in resources (land, buildings, schools, travel patterns, community services), service planning, resource management. Land ownership and valuation records.
Teaching	Academic institutions	Various	Demonstrations, teaching, spatial and statistical analysis and modelling
World databases	International scientific bodies, UN	Climate, oceanographic, atmospheric gases, land cover, land use. Changes.	Global monitoring and modelling of biophysical systems, climate, population, biomass, environment

The variety of applications, the disciplines involved and the expenditure on the systems are all expected to continue to increase over the next decade. Expenditure on computer software alone is predicted to reach $6 billion by 1995 as "geographical information systems are seen as the fastest growing sector in computing" [GIS World 1991] expanding by some 30% per annum.

In Australia, ALIC believes that despite the variations in development between the States "it is reasonable to predict from the current rate of progress that most States/Territories will have fully operational systems well before the turn of the century" [ALIC 1987:10] – a remarkable achievement, considering the cost and institutional difficulties involved.

In this atmosphere of growth where both public and private institutions seem to be caught up in a land information system wave, it is not surprising that perhaps over-enthusiastic claims are made for the technology. Symptomatic of these conditions is the fact that while the introduction of land information systems is usually preceded by some form of cost–benefit evaluation, post implementation evaluation studies are all but non-existent [Appendix C5].

Organisations, at least publicly, have faith that their systems are delivering the predicted benefits, be they in planning, problem solving or administrative efficiency gains. Under these conditions not many organisations have been too concerned to closely scrutinise their system benefits or assess whether they are in fact achieving their original or perceived aims. But, as some recent studies have suggested, perhaps they should [e.g. Healy & Ascher 1990].

Use of Land Information Systems

Given this enthusiasm, rapid growth and diverse range of applications (Table 1.1), land information systems are taking on the appearance of being of almost universal utility. This impression is possibly reinforced by the technical and managerial functions that these systems are designed to fulfil. Taking the uses identified in Table 1.1 as examples, land information systems' functionality may be characterised as follows.

(1) Land information systems are an *inventory tool* that hold observations made about the land. It classifies, records and maps observations about items, events and their relationship to other

activities and objects, be they planned communities or people, stop valves or shopping malls. Examples of inventories are multi-purpose cadastres [McLaughlin et al. 1985], natural resource inventories [Davis et al. 1990], and utility systems [Marwick 1988].

(2) Land information systems act as a *monitoring tool* to recognise changes in the inventory, identify where decisions and actions may be needed, evaluate programmes and regulations. Monitoring changes in land potential [Brown 1985], traffic patterns [Insignores & Terry 1991], and global biological diversity [Davis et al. 1990] exemplifies this function.

(3) As a *management* tool for implementing and overseeing a host of land based and land-related decisions and activities, be it for resource management [Walsh & McQuoid 1991], emergency management [Grainger 1991], the conveyancing of land and land use management [Nanningo & Tane 1990].

(4) A major advantage of land information systems is their capacity to act as a *forecasting and modelling tool* for "what if" studies in a mix of spatial, temporal and functional domains. Spatial and statistical analyses portrayed in textual and graphical modes are significant in marketing [Martin 1991], pollution and hazard control [Beck 1989], landscape changes and environment modelling [Environment Canada 1983].

(5) Land information systems are *planning tools* to examine and select courses of action in urban and regional planning [Harris & Batty 1992], provision of services and facilities [Newton et al. 1991], as well as in economic planning [England 1985].

Most installed land information systems perform some if not all of these functions, as much of the data and system routines are common. At least prescriptively then, land information systems appear to have all the necessary accoutrements required for problem solving: a data source to monitor, by which to identify potential problems; data and methods for formulating alternatives; modelling and forecasting tools for evaluation; and, lastly, statistical tools for measuring the consequences of choice. Yet, as the more detailed examination of both land information systems and policy- and decision-making processes in the following chapters reveals, this prescription for linking land information systems and decision-making processes is simplistic and flawed.

EFFICIENCY PROBLEMS

If we place these five functional areas of a land information system in a policy- and problem solving context, two broad groups emerge characterised by the types of problem it addresses. The first group comprising the inventory, monitoring and management functions, and to a lesser extent the modelling function, are essential tools for solving "efficiency problems" where the aim or objective to be attained is defined and understood. Quade [1982:22] likens these functions to operational research procedures, with the distinctive approach of developing

> a scientific model of the system, incorporating measurement of factors such as chance and risk, with which to predict and compare the outcomes of alternative decisions, strategies or controls.

He further notes that while operations research has broadened out to cover economic and social concerns,

> nevertheless, the term is still often used narrowly in almost the original sense to refer to the application of mathematics or logical analysis to help a client improve his efficiency in a situation uncomplicated by problems of equity or choice of goals.

It is this sense, this quest for efficiency through logical, rational processes that dominate today's application of land information systems. Thus references to efficient data handling, costs and time saving, elimination of duplication and waste in order to have more efficient decision making are prevalent in the land information system literature, particularly in Australia. "Low-level" structured problems, where the decision-maker has a clear objective against which to optimise for a solution, form the bulk of the uses described in Table 1.1.

Such problems lend themselves to algorithmic processes for evaluating alternatives, to modelling techniques for predicting outcomes and formal analysis for measuring utility – all concepts which are closely allied to the ideals of improved land information management practices: accuracy, reliability and certainty [Dale & McLaughlin 1988:13]. There is, therefore, at least *prima facie* evidence that the use of land information systems technology is of benefit in solving those kinds of problem. There is little evidence, however, to suggest that these benefits are also applicable to the second group of problems.

STRATEGIC PROBLEM-SOLVING

The means–end conditions applying in efficiency problems is largely absent from the second group of problems concerning strategic planning and policy issues. Here the goal to be achieved is part of the solution to the problem; that is, they represent strategic-choice or choice-of-objective problems [Quade 1982:20].

These "higher level" problems are typically found in public decision making when numerous and conflicting goals may surround a problem, its definition and resolution. While the control and management of land and land related activities are shared between the private and public sectors [Denman 1972:11], as the applications in Table 1.1 indicate, land information systems are used in a broad range of community planning and policy-setting activities that transcend the interest of any one individual or group, be it in the provision of services, in environmental management or land-use decision making. Hence, Justice Kirby [1984] observes in relation to land, "conflicting perspectives about land are always present. This is especially so when someone discusses the possibility of changing its status." Consequently, debate about the allocation and use of land, in common with many other public issues, has within it "a fundamental enduring conflict among or between objectives, goals, customs, plans, activities or stakeholders" – a conflict unlikely to be resolved completely in favour of any one position [Coates 1978, quoted by House 1982:10].

Under these conditions the real difficulty is not so much the decision making part (i.e. evaluating and choosing a preferred course of action as in the efficiency type of problem), but rather the problem identification component of fixing an agenda, setting goals and formulating alternative policy outcomes. As Mintzberg et al. [1976] note, strategic problem solving on the whole does not lend itself to formal analysis, nor does it necessarily rely on optimal outcomes through prescriptive processes:

> when decisions are made as to which problem, which reality is to be selected for solution, it tends to be a political process employing tools such as debate, bargaining, judgement, analysis as means to grope towards a decision.

This uncertainty, this ambiguity, usually applies to all phases of the public decision making process from goal formation through to goal satisfaction.

There is a tendency for unitary goals or agreed criteria by which to judge the decision outcome to be absent or ill-defined. Hence the solution process is at best only substantively rational when "one must take into consideration the political assumptions and public perceptions which are the front-end drivers of our policy system, and which determine the eventual decision" [House 1982:79]. The fundamental difficulty is to fulfil a number of expectations through the selection of an appropriate mix of goals. In this situation

> the data suggest no solution in themselves. Even after the quantitative data is collected and organised the pressing question still remains: what does one want to do? Sophisticated costing may provide considerable assistance in revealing the trade-offs among various alternatives – but the ultimate decision, the choice of the strategic approach to the problem, remains a matter of faith that will always elude rigorous quantification.
>
> [Schlesinger 1963]

The role, if any, of land information systems in problem solving of this kind, particularly as it affects public policy-making about land, has received scant acknowledgment in the literature or in practice. As a recent fifteen-year perspective on public policies and land information systems/geographic information systems notes,

> there is no (apparent) overall coherence or cumulativeness in the literature in general, as to what is being done or reported in regard to the application of IS/GIS/LIS to formulate and realize policy objectives.
>
> [Smith & Wellar 1992]

Where planning issues are addressed, e.g. physical planning [Nash 1980] in the provision of housing [Crawford 1982], the reported activities and methods mainly assume that the problem has been fully defined and the goals set; that is, they are solely concerned with the selection and evaluation of alternatives within a defined policy framework. Others, such as Ive & Cocks [1988] and Laws et al. [1989], include the problem definition component only to the extent of including existing policies, or deriving them as part of the planning exercise. In each case, and in those described by Niemann [1987] and Simpson [1987], where policy influences are recognised *post facto* to evaluation, the policies are apparently unaffected by the presence of a formal information system even though *prima facie* these systems are designed to at least assist or influence the policy process.

In Schlesinger's terminology, strategic problem solving does appear to be an article of faith rather than one of quantification. But as the land information system community at least aspires to influencing public policy processes at these "higher" levels, the extent of this influence should be determined and characterised. It might then be possible to obtain a more realistic assessment of the connection between land information systems and the public policy processes.

Concept and Framework of Thesis

THE THESIS

The background discussion has highlighted several underlying beliefs of the land information system community regarding the relationship between information and public decision making processes with respect to land. Firstly, there is assumed to be a strong causal link connecting the availability of reliable, consistent information and effective problem solving. This extends to include the perception that the quality of this information (accuracy, completeness, timeliness) also has a direct bearing on the quality of the decision made. Embedded within this belief is the conviction that somehow land information system based techniques are better, or more proper, than the methods being used by the current public decision process and therefore should be adopted as part of that process. Because of this, it is assumed by the land information community that when available, the information will be used in the public policy process. In short, there is a belief that:

- It is uniformly and a priori valuable to use information made available by land information systems in public decision making processes.

- The current decision process is flawed and should be improved by the addition of more objective and formal information and analytical methods.

- Society as a whole will benefit from the use of information provided by land information systems: the decisions regarding the use and allocation of land would be more honest and accountable if explicit, formal and structured information and process were employed.

- Policy makers' decisions concerning utilisation should be guided primarily by assessing the quality of the information provided.

- Land information systems are not now being used in decision making, or at least not to their full potential. It is beholden on us "to increase the awareness in all jurisdictions of the importance of the use of land information for decision making" [ALIC 1988:3].

Where information is being used, or could be used, there is a further assumption that it will be used rationally, i.e. in a process that systematically identifies and evaluates alternative courses of action, selecting the one most likely to achieve a given goal. Perhaps more from a lack of thought or awareness *all* policy and decision making tends to be viewed from this rationalist perspective, mirroring the successful application of the technology in solving the efficiency type of problem. Yet as, for example, Worrall [1989:133] suggests by his statement that "GIS will stand and fall by their perceived usefulness in public policy making", at least some land information system practitioners believe their systems have utility for other kinds of decision process. There is therefore a general feeling that decision makers *could* make *better* use of land information systems.

These claims regarding the connection between formal information systems, decision making processes and (particularly) policy processes, are being challenged. Firstly, as Calkins et al. [1989] note,

> The assumption that better information leads to better decisions in the real world has not been confirmed. This has been taken as a given in assessing the use and value of geographic information systems in decision making in spite of its lack of confirmation.

Secondly, even accepting that a direct link between land information systems and decision making processes does exist, then the claims being made by the land information system fraternity tend to be too general and fail to discriminate, or acknowledge, the complexity and political nature of most public decision making processes. Formal information process and analysis do not always sit very easily with politics. Analysis tends to assume that explicitness and clarity of reasoning are virtues always to be pursued; that rational, optimal choice processes are *a priori* a superior decision paradigm for solving public sector problems. Politicians, on the other hand, may find it pays to obscure issues in the interest of getting things done and stilling opposition; and that only by determining preferred policy positions through informal, subjective procedures are decisions likely to survive the political process and ultimately be adopted. The land information systems community has been generally insensitive to these differences, has failed to recognise the information required to make decisions in this political environment. This is not to say that land information systems do not have a place in this process: they may. But that place is likely to be quite different from what most in the land information community perceive it to be; that is, much more a background than a foreground role; one that suggests rather than directs the outcomes.

Thirdly, to be of any significance in the public decision making process, land information system practitioners need to, *inter alia,* acquire a better understanding of the needs of decision makers in relation to *their* environments. I shall argue that a crucial requirement in the policy process is the availability of inductive learning tools and data structures through which to gain insights and understanding about the issues, so that policy-makers can begin to explore the possible effects of their policy choices. The argument therefore centres around the need to move from land information systems being an end in themselves, to their becoming an enabling device within a broader decision making environment. This will involve practitioners developing a much broader knowledge of the processes that policy makers in the public domain are involved in, as well as devising and incorporating more appropriately structured systems and tools.

In short, this thesis questions the role that present day land information systems play in the public policy process, and practitioners' perceptions of this process. It suggests that the land information systems community, like many before it [Inbar 1979:77], has proved itself to be fallible by taking limited and selected sampling (efficiency and effectiveness gains), organising these on the basis of some simple principles (rational decision making procedures), and unknowingly extended these cues into what it believes to be a like environment (public policy process).

Muddling the operational efficiency and effectiveness gains that land information systems are presumed to provide in record keeping, for chiefly management purposes, with "better" public decision making in general, is but one symptom of this transposition. The lack of differentiation between the formal information requirements for strategic problem solving, such as in land management policy, and ordinary problem solving tasks in land management is a further manifestation of any depth of assessment in relating information to decision processes in general. I suggest that without such an assessment, and without some comprehension of how public policy is made, the land information systems community is in danger of losing much of the credibility it has established in the applications where it is, and has been, of benefit.

Accordingly the subject of the thesis is land information systems and the part they play in land-related public decision making processes. Specifically I posit, with respect to policy and planning issues concerning land management, that:

1. As currently conceived and implemented, land information systems are, by function and origin, of limited use or influence in public policy processes
2. These limitations of land information systems are largely ignored or overlooked by land information system advocates.
3. Land information systems' data and functional models can be modified to enhance the chances of these systems being utilised in the land management policy process.

METHODOLOGY

To test this thesis an extensive literature review was conducted to formulate a model of how public policy is actually determined in the land management arena and the place of rationally derived information in that process. This is contrasted with the rational policy formulation processes and the direct instrumental use of information envisaged in the land information system literature.

The model developed from the literature review was then tested against my own experience and that of a Tasmanian Government agency in using land information systems for land management policy and planning. With some exceptions in degree rather than substance the model was found to reflect the relationship between the policy process and land information use in that department.

Given that the model has to span the full range of uses to which land information systems are being put, from administration to policy planning and the part that formal information plays in each, the literature review has to cover a number of topics and disciplines. These include land information systems themselves, land management planning and policy, the decision 'sciences', policy studies and analysis in both the public and private domains as well as the reported research on information utilisation in decision making.

The empirical data used to test the validity of the model is of two types, background data and information specifically gathered for the validation task. The background data consists of my

1. Seven year membership (1983-1990) of the Land Information Executive of the Tasmanian Land Information Council, a body established at departmental secretary level to co-ordinate and oversee the introduction and use of land information systems in government agencies.

2. Participation in the "National Conference on Better Land-Related Information for Policy Decisions" (1984) and the subsequent drafting of the recommendations resulting in the establishment by the Federal Government, under the Prime Minister's Department, of the Australian Land Information Council (ALIC).

3. Investigation and report, on behalf of the Secretary, Victorian Treasury, on the operations of LANDATA (1990), the organisation established by the Victorian Government to co-ordinate and deliver integrated land information products across government agencies.

4. A report entitled Land Information – Managing a Vital Resource – A Strategic Directions Paper (1993) prepared on behalf of the Secretary, Tasmanian Department of Environment and Planning. The report's main recommendations were subsequently adopted by Cabinet and funded.

The specific information collected to test the model is made up of

1. Interviews with successive secretaries to the Department of Lands, Parks and Wildlife (later the Department of Environment and Planning) – the primary land management agency in Tasmania, firstly with Mr Bob Annells (1987) and secondly with Mr John Ramsey (1994).

2. Interview with Mr Bob Graham (1987), Minister for the Environment and Planning at the time of Gordon below Franklin Dam dispute – a major world wide environmental/land use issue in southern Tasmania.

TERMINOLOGY

Terminology – Land Information Systems

A number of terms have evolved to describe computer based information systems which hold information about the characteristics of objects in space plus their mathematical and topological relationships. Classes of systems with these properties are generally referred to as spatial information systems [e.g. Dale & McLaughlin 1988:10].

The *technology* of spatial information systems is generally referred to as geographic(al) information systems [e.g. Marble 1984], although, and this is where the confusion arises, it is also used to describe the various applications of the technology by a range of disciplines to a host of tasks (e.g. as illustrated in Table 1.1). In this thesis we are concerned with one particular application of geographical information systems technology, namely the storage, manipulation and portrayal of land and land-related information, especially information concerning land management. The term *land information systems* will be used in this sense. This is also consistent with the terminology adopted by ALIC. As they note:

> Many terms have been used to describe the new land information management technology and procedures. ALIC has determined that within Australasia, land information systems (LIS) is the preferred term to use to describe these systems which have been developed to better manage land information.
>
> [ALIC 1990:2]

The literature, however, freely intersperses the terms "land information systems" (LIS) and "geographical information systems" (GIS).

Terminology – Problem Solving, Decision Making and Policy

Each of the terms *problem solving*, *decision making* and *the public policy process* will be used extensively throughout the thesis. It is therefore important that the meaning attached to each of these be clear, as well as the relationship of each term to the others. This clarification is all the more important as the terms are widely used across a range of disciplines, e.g. administration and organisational science, operations research, policy science, often in different context and with different shades of meaning. For example, referring to the policy process, the terms *policy evaluation*, *policy studies*, *programme evaluation*, *public* *management science*, *policy science* and *public policy analysis*, while they could be distinguished, according to Nagel [1990:4] are often used to mean the same thing.

Problem solving and public policy processes may be considered as being on a continuum defined by the nature of the decision making process employed. The continuum extends from the fully defined decision making processes at the routine administrative level to unstructured policy making processes at the other end, with problem solving or semi-defined decision making in between. In turn, the decision making process is largely determined by the type of problem being addressed, their structure, and the kinds of problem solving activities used in the problem resolution process. These relationships for problem solving and policy making are summarised in Table 1.2. A similar type of relationship exists between information and decision making as indicated in Table 1 Appendix C2.

For explanatory ease, each of the terms will first be defined and then the interplay between them discussed.

The term *problem solving* will be used to refer to the solution of problems whose structure, that is, their definition and the ends to be reached, has been at least partly defined or programmed through some earlier independent strategic planning/policy process. It is assumed that the solution of the problem will be through a formal, mainly rational, means–end process. As covered more fully in Appendix A2, adopting a rational based problem solution process contains within it the beliefs that:

- Behaviour will be interpreted intelligently against some predefined yardstick (a goal or aim).
- Actions and beliefs shall be consistent over time achieved by adhering to objectivity and truth.
- Correct rational behaviour is measured by systematically relating consequences to objectives through the application of reason.

In practice this translates to a problem solving process which ideally consists of:

- the systematic identification of alternative courses of action, through
- a comprehensive analysis of all available information, to

Table 1.2
<u>Decision Making Continuum</u>

Characteristic	**Problem Solving**	←→	**Policy Process**
Framework	Externally defined Limiting		Undefined, unbounded
Process	Formal, analytical Comprehensive, synoptic Serial (means–end)		Agreement, comparative Incomplete, selective incremental, continuous
Activities	Sequenced definition of problem, goals, selection of alternatives, evaluation and choice of outcome		Simultaneous and continuous examination, evaluation and choice of policy options in no particular order
Application	Management, Planning		Strategic planning and policy setting
Decision Making	Conscious, discrete	←→	Discovered, emergent

- create an understanding of the problem, from which

- an optimal decision can be logically deduced.

Ordinary problem solving therefore involves a "scientifically" reasoned and defensible decision process producing optimal or "true" answers.

In contrast, the *public policy process* or strategic problem solving in the public domain (as opposed to ordinary problem solving and ordinary decision making above) is quite a different process. Following mainly Lindblom [1959, 1979], the characteristics of the public policy process may be summarised as follows:

- Attempts at understanding the problem are normally limited to policies that differ only incrementally from existing policy.

- Arising from the above, a relatively small number of alternative possible policies (i.e. means) are considered.

- Ends and means are chosen simultaneously and indefinitely explored, reconsidered and discovered.

- Problems are not solved but repeatedly attacked.

- Analysis and policy making are remedial, moving away from ills rather than towards known objectives.

- At any one point in the process, the analysis of consequences may be quite incomplete.

Policy "decisions" therefore, tend to emerge or be discovered, often well after the event. In the policy process, all activities, problem definition, problem selection, goals and alternative selection, as well as the decisions associated with them, are continuously reviewed, evaluated and changed. Decisions just happen in the course of this process. In part this is because, as Inbar [1979:18] notes, the closer we are to the policy making end of the decision making continuum,

> the more value premises and goal setting can be expected to enter into decisions. Conversely, the closer we are to the routinised implementation end, the more values and socio-political considerations are irrelevant or illegitimate, and the more we can expect decisions to approximate the problem solving model of information processing.

Yet, as Emery [1976:359] observes with respect to public policy, it is often possible to find "a tolerable amount of rationality in decision making when the process is viewed as a whole in its social or political context".

Decision making therefore needs to be viewed in its context; it is a discrete, considered and conscious process in problem solving; a continuous almost osmotic process in public policy making. It is a distinction that by and large has escaped the land information community. It is also a distinction that is at the core of this thesis.

The programming for ordinary problem solving is normally deemed to be through some strategic planning activity which establishes the rules and actions (policies) to be followed at the administrative and managerial levels to bring about the desired change. In the public sector, what is termed public policy is usually the culmination of a number of analyses, recommendations and decisions, made by public officials at various levels of government and ultimately approved at the political level. Public policies lay down the rules and the framework within which policy is to be implemented through programmed (ordinary) problem solving at the lower levels.

There are, therefore, well established theoretical roots to the idea that policy making and problem solving (implementation) are quite separate steps in an overall chain of public decision making. Rational models of planning and policy making view implementation (or execution or action) as a separate process which takes place after policy has been formulated. Similarly, administrative theory often attempts to draw a sharp distinction between policy and administration [e.g. Simon 1975]. Policy is considered to be a decision as to what to do: administration is getting it done.

In practice, however, it is notoriously difficult to define where policy ends and implementation (or administration) begins. Public officials inevitably exercise discretion in deciding on the details of how a policy is to be implemented and, therefore, inevitably shape policy. As a result, there is a dynamic interaction between policy and action: "at any point in time it may not be possible to say whether action is influencing policy or policy action" [Barrett & Hill 1984].

There is then, no simple linear progression from policy to implementation, there is in this sense so no clear-cut division between problem solving and the policy process in the public sector. Should policy learning models such as those proposed by Sabatier [1987] and others be formalised and adopted in practice, then the boundaries between policy direction and policy action will be drawn still closer together. But, at least for the moment, since the origin of land information systems lies firmly in the rational decision making camp, problem solving and the public policy making process will be treated as being independent activities.

Terminology – Land management

The thesis deals with the contribution, influence and impact that land information systems have in the formulation of public policy, and, in particular, land management policy. Following Dale and McLaughlin [1988:4], land management is taken to "entail decision making and the implementation of decisions about land", covering the full decision making spectrum (Table 1.2) from "fundamental policy decisions about the nature and extent of investments in the land ... to routine operational decisions made each day by land administrators such as surveyors, valuers, and land registrars."

In keeping with public policy formulation processes in general, it is assumed that land management policy is the end product of a long continuous process involving public officials, policy analysts, policy advisers, political advisers and heads of agencies, all to a greater or lesser degree participating in proposing, selecting, analysing, refining and choosing preferred policy positions for ultimate approval at the political level. For convenience and brevity, unless it is necessary to refer to a particular policy actor the term *policy maker* will be used. Likewise, unless it becomes necessary to refer to a particular stage or policy formulation activity, the term *policy process* will be employed.

Land management policy will be used when it is necessary to emphasise it or distinguish it from general public policy process, and particularly in relation to the place that land information systems have or may have in that process.

THESIS ORGANISATION

The thesis has been organised into four parts. The first, comprising Chapters 2 and 3, describes the operations, origins and use of land information systems and their connection with the physical planning and policy process as well as their role in improved land information management procedures. Chapters 4 to 6 constitute the second part, which examines problem solving and public policy processes to gain an understanding of how information directs, influences or is otherwise involved in each of these processes.

The third part looks in detail at the information utilisation literature and draws from that a model of how information in general is utilised in the policy process. It goes on to compare these findings with some empirical data on how land related information is actually used in the land policy area. The last part of the thesis evaluates the role that land information systems do, or through modification perhaps could, play in public policy processes concerning land and land-related matters.

Overall, the thesis moves from applications where land information systems are known to be of benefit and influence to applications in the policy arena where many fondly hope they are of some significance and consequence.

Throughout, the perspective adopted is an information interventionist one: what is being tested is the use and influence of the information emanating from formal computer-based land information systems on public policy processes, particularly as it affects land management policy making. Hence, Chapters 2 and 3 look at how land information systems obtain, store, manipulate and portray information relating to land, and describe the origin of these systems in the systematic, information-dependent planning movement in the 1970s. Chapter 2 describes the system and data components of a land information system and how these form and shape the kinds of information product that result. Chapter 3 then examines how these properties of land information systems lead to these systems being aligned with system planning procedures and a drive towards improved land information management practices. It postulates that the benefits of land information systems credited to each of these activities have been, and are, without foundation, being assigned each to the other; one result of which is that at least some sectors of the land information systems community are continuing to credit the operational improvements being achieved at the managerial decision making level to planning and policy making in general, despite the substantial changes that have occurred in these activities since land information systems began to be introduced.

Chapters 4 to 6 (Part B) look at these public problem solving and decision making processes in some detail to explain the place that formal information occupies in each of them. Viewed from a largely unrelated and disparate field such as land information systems, public decision making appears to be (and is) an imprecise and complicated process; with many human- and organisation-related random variables, covering a wide variation in types of issue with extreme differences between affected interests and actors. In addition, individual decision makers have different perceptions of information and make decisions in very different ways.

For these reasons in Chapters 4 and 5, in line with the rationalist tradition of decision making, problem definition and decision making processes are initially taken as being independent activities, and the place of information in each is discussed separately. In Chapter 6 this distinction between problem definition and decision making as distinct operations is abandoned in favour of some heuristic models of the public policy process in an effort to present a reasonably rigorous description of the policy formulation process, and the potential place of formal information and analysis in it. The description presented provides a setting for a series of conclusions as to where, in the scheme of public policy formulation, land information system methods fit.

On the way, in Chapter 5, some factors on the type of land information system which might be required for supporting the policy process are defined and contrasted with the operation and structure of present-day land information decision support systems. This is achieved by summarising a series of prescriptive models describing the relationships, and interaction between knowledge and information on the one hand, and land information systems, problem solving and decision making on the other.

In the third part (C), Chapter 7 draws on the results from research on the utilisation of knowledge and information, together with the models and findings from the previous chapters, to assess the parameters that are likely to affect the nature, influence and impact of land information systems on land-based public policy issues. This results in a model illustrating the kind of contribution that information produced from land information systems make in the land management policy process. The model is then contrasted and compared in the next chapter with empirical evidence on how land information is currently being used in problem solving and policy setting. These findings are used to refine the model derived from the literature on the relationship between land information and its use in the policy process.

The last part of the thesis discusses how, and under what conditions, land information systems could enhance their potential to contribute to the public policy process. This leads, in Chapter 9, to a series of recommendations for a system to support the land management policy process, including its form, functionality and content.

The concluding chapter uses a set of knowledge change variables which influence utilisation to summarise the conditions under which information emanating from policy-based land information is likely to be employed with effect in the policy process. From this summary a number of conclusions are drawn about the existing and potential role of land information systems in the public policy process concerning land management issues.

PART A

Land Information Systems and Their Use

CHAPTER 2

CHARACTERISTICS AND FUNCTIONALITY OF LAND INFORMATION SYSTEMS

Introduction

Like most even modestly complex systems, land information systems may be viewed from a number of perspectives. One such perspective, a functional view of land information systems as an inventory, monitoring, management, modelling and planning tool, was briefly discussed in the previous chapter. In this chapter another perspective will be developed, one that examines how land information systems develop, build and model information about prescribed selected views of land, its form, characteristics and use.

The purpose of this model is to highlight the nature, organisation and characteristics of the information about land that is typically held in a land information system and the technical function these systems can fulfil, so that in later chapters their utility, appropriateness or relevance for various forms of decision making, planning and policy may be assessed.

The chapter will therefore firstly describe some general characteristics of land information systems and their physical implementation, then offer an interpretation of these systems from an information representation/ modelling point of view.

SOME DEFINITIONS OF LAND INFORMATION SYSTEMS

Land information systems represent a specific group of information systems whose primary function is to provide information about the land, its resources and the activity that takes place upon it.

An information system in general may be defined as "A system providing information when, where and how you need it" [Richards 1980:4], or more fully as:

> a combination of human and technical resources, together with a set of organising procedures, that produces information in support of some managerial requirements.
>
> [Dale & McLaughlin 1988:8]

Specifically, a land information system

> is a tool for legal, administrative and economic decision making and an aid for planning and development which consists on the one hand of a data base containing spatially referenced land related data for a defined area, and on the other hand, of procedures and techniques for the systematic collection, updating, processing and distribution of the data. The base of a land information system is a uniform spatial referencing system for the data in the system, which also facilitates the linking of a data within the system with other land related data.
>
> [Definition adopted by Commission 3 of the Fédération Internationale des Géometres (FIG), Bulgaria, 1983]

While this definition has its critics [e.g. Hamilton & Williamson 1984], it has been widely adopted and identifies the purpose of a land information system (a tool for decision making; an aid for planning), together with some of its technical features for data collection and manipulation as well as what distinguishes a land information system from conventional information systems – the existence of a spatial referencing system to locate and connect data on, above or below the earth's surface.

The definition adopted by the Australian Land Information Council (ALIC) [1988] is similar, but lists a number of applications that reflect its emphasis on improving land record management.

> Land information systems may be thought of as a series of procedures and mechanisms to maintain records and retrieve and analyse information about land. Typical information may include details of land administration, title records, land tax, data on the man made or natural environment, or socio-economic statistics.

A similar accent is given in the definition offered by the states of South Australia, Victoria and Western Australia, and by the ACT [AURISA 1985, LISSC 1982]. Other definitions such as offered by Marble [1984] stress systems technical capabilities for the storage and analysis of spatially related data, while that put forward by the NSW State Land Information Council (SLIC) views land information systems as a means of giving access to government information [Hart 1987].

A broader view of land information systems is one that contains the notion of forming a resource of information on land and its attributes through integrating spatially, and by subject, a number of separately developed and controlled systems. The concept is similar to the information as a strategic, corporate resource in management information systems [Davis &

Olson 1985:630] that provides a basis for strategic planning and policy formulation, in this instance about land.

A definition of a land information system embodying the formation of such a resource of information about land was prepared by the author at the request of the Tasmanian Land Information Executive in June 1983 as part of a land information policy statement for that State. The statement with slight amendments was adopted in October 1983 and reads in part:

> The term Land Information Systems (LIS) is taken to be a means of co-ordinating and managing the land-related records maintained by separate government agencies so that information may be exchanged and combined freely and efficiently to provide a comprehensive and up to date community resource of information about land through common procedures, indices and classification systems.
>
> 1.0 The definition attempts to embody the notion that a LIS:
> .1 Is a means to coordinate and integrate the separately held land-related information of autonomous government authorities.
> .2 Coordinates and assists the development by individual authorities of improved systems of storing, retrieving and manipulating land information records.
> .3 Creates an integrated, comprehensive and timely resource of information about land which may be used for a multiplicity of purposes.
> .4 Does not deprive any authority of any of its traditional sources of information, although it may be obtained from different sources.
> .5 Does not create any new data or new records – it just uses the existing ones more efficiently.
> .6 Does not mean the establishment of a large central department which collects, controls and distributes information.
>
> 2.0 The purpose of a LIS is to facilitate the flow of information between departments, authorities, local governments, and the general public, thereby:
> .1 Improving the access to information held by other agencies through the
> .2 Removal of existing redundancies, duplication and inconsistencies in data collection, storage and retrieval methods enabling the
> .3 Production of new services and products using existing data.

3.0 To achieve its aims, the coordinating authority administrating a Land Information System must have a mandate to derive:

.1 Which authorities shall be responsible for which data items.

.2 Agreed procedures for classifying, collecting and encoding land data.

.3 Standards for digital encoding and exchanging land data.

.4 Agreed standards for storing and manipulating digital graphical (map) data.

Bringing about such integrated collections of information about land as envisaged in this statement is essentially an exercise in technical, management, organisational, and political coordination and as such it is fraught with difficulties [Zwart 1981, LANDATA 1991, McLaughlin 1991]. Nevertheless, all Australian states and a number of other jurisdictions, notably in Canada, are presently endeavouring to realise this concept.

It is this broader model of a land information system that is adopted for the purpose of this study as it not only embraces what is – the individual systems of today – but also what the land information community hopes will be the future. The study will therefore take land information systems to be a computer based system for storing, integrating, analysing and portraying a spatially referenced resource of integrated, comprehensive data about land and land-related data designed to be used for a multiplicity of purposes by a multiplicity of people in a timely and reliable manner.

Operations and Functions of a Land Information System

To implement a system containing the above properties, the system has to be functionally organised along the lines of the schematic in Figure 2.1.

In the figure the resource of data is represented by the storage facility, the integration process by the manipulation function, and the ability to support multiple users by it, and the interpretation and analysis unit. Information on the original data, or its transforms, is made available through the presentation module and acts to inform potential users.

STORAGE FACILITY

Land information systems are commonly thought of as holding two basic types of information:

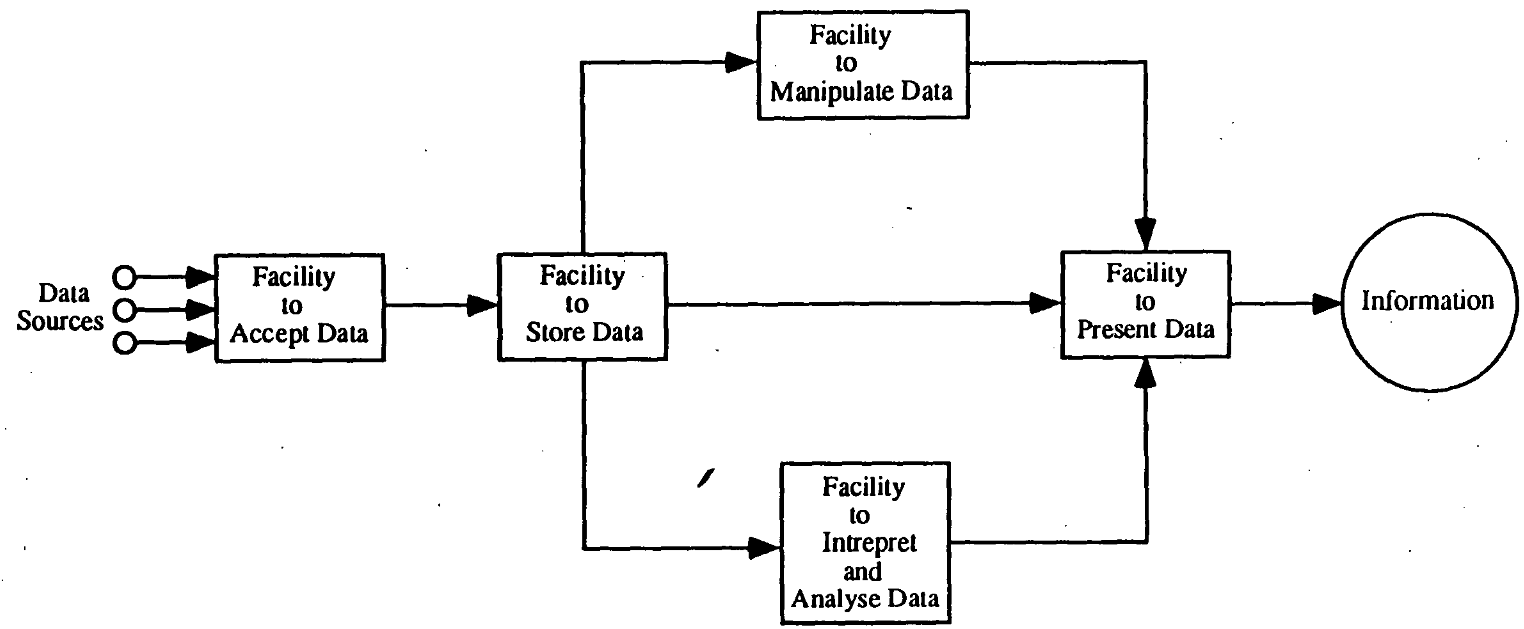

Data Sources
Facility to Accept Data
Facility to Store Data
Facility to Manipulate Data
Facility to Intrepret and Analyse Data
Facility to Present Data
Information

Figure 2.1

1. The characteristics or variables associated with an object or event, plus

2. Its spatial location, i.e. the location in geographic space.

Hence if data on soils were included in a land information system, attributes such as pH, depth and classification would be held in the textual portion of the system while the location of the sample pit or the bounds of the soil type's geographic extent would be part of the system's spatial data.

With few exceptions both the spatial and the descriptive data are stored in some form of data base, typically structured as described in Appendix C1. Spatial data may be held in vector format (points, lines and areas), in cellular or raster formats and as images. Topology – that is the relationship between the spatial primitives – is also normally explicitly stored enabling spatial properties like adjacency, proximity, containment and connectivity to be directly modelled. A more detailed discussion of these aspects of land information system may be found in Appendices C1 and C4.

MANIPULATION FACILITY

To work on the data in the store there are a series of user invoked operators. In the case of the descriptive data, these are the usual arithmetic and boolean operators provided with commercial data base management systems enabling selective retrieval of data on the basis of user-determined criteria. They provided "the ability to select data, produce maps and reports, on the basis of attribute values" [Kevany 1985].

These textual operators are extended into the spatial domain by allowing them to query and manipulate the locational data through data retrieval, map generalisation, map abstraction and geometric operators [Dangermond 1983]. By using these operators, for instance, data on forests may be transformed to data on fire hazards, or land values to redevelopment potential [Sedunary 1987]. An example of the process involved, with its possible outcomes, is illustrated in Appendix C4.

ANALYSIS FACILITY

The above operations essentially re-format or transform the original one-dimensional descriptive data and cannot operate on linear or areal data entities. For these other operators that allow for the free mix of point, line (network) and areal data entities are required. A partial list of such capabilities may be found in Appendix C4 and a more complete set in Burrough [1986:88-91]. With these tools: such point operations as proximity analysis and clustering or group mapping may be undertaken [Lam 1986]; network analysis and allocation problems using line and node features and spatial correlation and contiguity measures based on the areal operators of overlay and intersection [Dakan 1985]. As Burrough comments, by "stringing together sets of simple analyses ... [we can] ... create an almost unlimited range of capabilities for data analysis" [1986:81].

PRESENTATION FACILITY

The function of this unit is to communicate the results of the data manipulation and analysis in a form that is meaningful to the intended user, be that a person or another computer. For transmission to people, a range of mapping, graphing and tabulating tools are normally available to display the information on paper, film, optical disk or visual display units, in batch or interactive mode, under programme or direct user control. Spatial information may therefore be displayed in its traditional form of maps, albeit in digital format, with content, context and form adjustable on demand.

Land Information Networks

Physically, and conceptually, land information systems are being formed by connecting a number of individual, autonomous information systems with the above characteristic to form a comprehensive, "total" information resource on land. Some early systems of this type were implemented centrally [Ayres 1975, Wallner 1976], but because of the growth of individual systems in various agencies and jurisdictions, it is now accepted that implementation will be by a land information system network [State Coordinate Council 1979, Palmer 1984]. This approach, while not avoiding the organisational and institutional difficulties inherent in implementing land information systems [Zwart 1981], does at least reduce them by matching the technology (distributed) with the organisation of the data, i.e. also distributed [Zwart 1984].

Its physical manifestation will be a network of computers probably connected by high-speed, broadband, communication networks working in an agreed manner. Normally, and conceptually, a "land information system" then becomes a transfer mechanism between separate data repositories usually managed by different government agencies [ALIC 1990:6]. Hence, as Harper [1984:68] notes, a land information system is not a system, but rather a concept; a concept analogous to the Torrens title Register which has no physical manifestation save as a collection of separate records (e.g. notice of transfer, mortgages, certificates of title) linked by a set of statutory regulations.

Likewise a land information system is a collection of separate records (or systems), each established to serve a particular function, but each capable of being assigned a portion of the overall systems functions. Each component may act autonomously to perform its designated function, but if this action impinges on the activities of another node in the network, it has to do so according to agreed protocols and standards. Just as the records of the title register may be geographically separate, so may the nodes of a land information system. In each case, what constitutes "the system", what makes it tangible, are the procedural, communication, and data standards that bind the separate records together.

Land Information System Technology

Up until recently land information systems were confined to large computers, were expensive, complex and difficult to use. This is rapidly changing. The advent of easy-to-use dedicated desktop systems running dedicated applications but networked together for data-sharing and data access are rapidly replacing larger, centrally controlled systems for most tasks (Appendix C6). As a result, the use of land information systems is extending to a wide range of land-related socio-economic operational and planning tasks [Newton et al. 1988, Klosterman 1991], with the responsibilities for application design and use moving further and further downstream, closer to the people who are closest to the issues. These trends are evident, not only at the operational and management levels but also, according to Steger and Bannister [1992], at the policy level, where it is common in most agencies to "have policy analysis and research officers with ubiquitous computer knowledge in their professional ranks" using PCs with attendant sophisticated software. Some of the consequences of these trends in the policy area will be further discussed in Chapter 9.

Land Information Systems Features

In implementing the above concepts, land information systems implicitly build formal, surrogate models that are more or less objective representations of the location and description of land management activities. Such models require that prescriptions be available to define:

1. What land/land-related information should be included in the model
2. How observed data should be converted for inclusion in the model
3. The conceptual and physical representation of the data model in a computer
4. The relationship between data items in the model
5. The operations that are permitted on the model
6. The level of confidence in the data and the results produced by the model.

The resultant land information system therefore provides a highly selective, formally defined description about land – a miniature simplified representation of what is a many faceted, complex set of relationships and entities. This simplification, with its accompanying formal rules, strongly influences the nature and scope of the information resource formed by a land information system. It also has a direct bearing on the possible use and utility of the information produced by these systems, some consequences of which are outline in the preliminary discussion to follow. A fuller treatment will be given in Chapters 4 to 9.

SELECTED REALITIES

As mentioned, within any one land information system, groups of data are organised and collected according to some prescribed criteria which define a desired subset of reality. The prescription for this reality is normally determined by some user or professional community, designed to meet their particular information needs and applications. The prescription sets down norms as to what data are to be selected for retention from all available data, indicates how it will be represented or quantified, and defines its level of detail, method of collection, how it will be described, its spatial and temporal reliability and resolution, and so on. Data are therefore formally described in terms of some model of reality that acts as a yardstick as to its validity, authenticity or compliance with the standard. Measures of data quality and conformity are therefore established in order to attempt to gauge the relevance and reliability of any data item(that is, the trust that can be placed in it).

The land information systems community is going to great lengths to ensure that such standards are formulated and enforced, not only for individual systems but for land information networks as a whole. To maintain consistency in the data, computing and communication domains standards are seen to be needed: for data classification, nomenclature and definition; for data models, their representations and encoding as well for their digital transmission between systems [Zwart 1991b]. As a result, the land information systems community considers it needs totally defined data models operating at all stages if "data quality", and hence consistency with a preferred view, is to be maintained.

Yet at the same time there is a fundamental tenet of the land information system concept, one which requires the same information resource to be employed for a multiplicity of tasks within and across different levels of decision making; from routine and ad hoc decisions, to administration and policy making [e.g. Clapp & Niemann 1980]. This applies not only to individual "corporate resources of information" – as in management information systems [Berry & Cook 1982:489] – but also to land information networks a whole. Land information systems are to be viewed as a community resource requiring a corporate approach to its management "across all sectors to ensure maximum benefit to the community" [ALIC 1990:6].

In a land information network this implies that data from a number of functional and administrative domains must be capable of being readily combined to form an integrated resource of information from which may be produced composite information to serve the needs of a largely open-ended, and in the main an unknown, constituency of users. For this virtual resource to be formed, not only do we need standards to link data with similar identifiers and index structures, but we also need a common language in the form of agreed classifications and definitions.

Most countries are therefore in the process of formulating and implementing data exchange standards [Zwart 1991b]. These kinds of standards, however, tend only to integrate data sets numerically or "mechanically", thus providing just one way of combining data. They, like most transforms, have great difficulty in encompassing social processes like values, context or perspective, or in communicating information across disparate disciplines and cultures [Porter & Niemann 1984 (Appendix C5)]. As each of the component systems comprising the network is in itself some small subset of reality, determined by the norms and values of the originating discipline, what is being attempted in a network is the integration of these into some shared, greater proxy for the real world. The land information systems community hopes that in the process of integrating and reconciling these, at times, contradictory realities, data will not be overlooked, ignored, over- or under-emphasised, or rejected from credible standards-conforming sources. The process, however, may, like Lasswell's promotional stage, be creating "a comprehensive, consistent, though fundamentally erroneous [cognitive] map of reality" [1975:165]; one that is of questionable value and utility in anything but the most structured forms of decision making and planning.

Despite these limitations, the promulgation of and adherence to standards are at the core of the land information system concept but, as is argued in later chapters, they may also be the very factors limiting its applications and utility, especially in the public policy domain.

DISCRETE DATA

The process of forming the information resource, of assembling a complex whole from component parts, is a classical reductionist approach – the notion that in order to understand (know) something it has to be first reduced to its simplest form. Land information systems do this to represent land, its properties and use through partitioning the task of storing and handling information on land into a number of simple, manageable models and operations. This is achieved, firstly as described above, through definition of standards that reduces the complexity of land and its uses to a series of simple items whose properties and relationships are defined by formally described data models representing a limited but desired view of reality.

Secondly, in practice it means that data is held in its most elementary or discrete form, as is the norm at administrative, if not at the planning and policy levels. Thus, in many systems the emphasis is on the land parcel as the smallest areal unit – simply because so many activities and decisions (hence data) refer to it. For example:

> The individual parcel of real property is the cornerstone of any land data system regardless of the degree of sophistication. Practically all service provided by [local government] can be related directly or indirectly to the parcels of land.
>
> [Meiszer 1978:44]

(A more extended discussion on parcels and parcel based systems may be found in Appendix C4.)

In Meiszer's case, the spatial unit of data collection (the land parcel) and of decision are the same. In other situations, for example physical planning, the spatial unit of collection and decision are often not the same, i.e. the planning units about which decisions are being made may be combinations of the unit data collection. When this occurs, the data has to be aggregated to the new spatial unit on the basis of rules or stated assumptions that represent (model) the relationship between the two spatial units and the data for each. In many cases it is possible to establish valid rules, but in other instances how to assign or proportion data to alternative spatial units is not at all clear. For instance, should population statistics at Collector District level be allotted to land-use zones on the basis of area, number of households or number of dwellings? Moreover, if we wish to use a land information system indirectly to gain an understanding of or an insight into a particular land management issue, rather than for formulating a choice or reaching a decision, then the reductionist, discrete data models on which most land information systems are normally based may in themselves be inappropriate, a hindrance rather than an asset as is commonly believed. How these kinds of difficulty may influence the utility of land information systems in the policy making processes will be discussed in Chapter 6.

SPATIAL SUBDIVISION

To depict spatial objects and distributions, simple manageable spatial entities need to be employed. As space is a continuum, it has to be subdivided into discrete units on either a regular (grid, raster units) or an irregular (vector) basis. In each case, the space and the phenomena it contains have to be broken up into discrete, areal, linear or point features.

When man-made or cultural features are involved, the spatial subdivision may closely match the representation on the ground, e.g. land titles, road networks or transmission tower sites. Naturally occurring phenomena, however, such as topography, plants or climate, and much socio-economic data, tend to vary smoothly over space. Organising these phenomena into discrete spatial entities becomes a subjective and imprecise matter. While the formulation of spatial reliability measures for cultural data is relatively straightforward, as Goodchild et al. [1992] note, the same does not apply to representation of continuous data. Presenting and manipulating spatially distributed phenomena in discrete units may therefore produce data that are scientifically "soft" and this exposes them to possible questions and doubts as to their reliability or objectivity. Land information systems under these conditions may produce inherently "soft" information, information whose dependability is open to interpretation and questioning. Yet, as House and Schull [1988:159] note, "executives are usually not comfortable with information provided in guarded, caveated, probabilistic fashion." Some of the ramifications of this on how such information may be incorporated in the public policy process is explored in Chapter 9.

DATA MODEL

Conventionally a land information system organises the elementary data items as a series of layers, each one depicting a theme or a subject connected or related to the others through a common spatial referencing system. The data model may, in some instances, establish additional secondary linkages between these themes, but the primary model is one of separation by themes, linkage by location. This model is one that Epstein and Duchesnau believe has "universal compatibility". They define it as

> The condition which means that various spatial information products, representing positional location of natural and cultural features, can be related to each other with a high degree of accuracy. Such compatibility allows secondary and tertiary users to take two spatial information products that may have been produced by different individuals for totally unrelated primary purposes, such as the location of a river and electrical transmission line, and accurately depict their relative positions in a single map.
>
> [1984:5]

This representational model may be appropriate when a common location is the primary reason for the interaction between two phenomena. Where their relationship is locationally independent or better described by, for example, an action or over time, the spatially dependent model of a land information system may become misleading or irrelevant. It is for reasons like this that Harris and Batty [1992], for example, call for model driven rather than data (locational) driven land information systems. It is also partly why land information systems as presently constituted, when taken beyond their inventory and communication functions, appear to be of limited appeal in the policy process (Chapters 4 to 9).

DATA INDEPENDENCE

Closely allied to the reductionist divide-and-conquer notion – to hit complex problems straight on [Churchman 1977:82-83] – is the information science concept of data independence, meaning that data are to be separated from the processes and organisations that supply them. That is, data are to be independent of function or context. In the jargon of the information scientist –

> A crucial step in the design [of an information system] is to separate the factual knowledge (data management function) from the procedural knowledge (application programme function) and the judgmental knowledge (user interface and decision support functions) and to provide a translation, a control mechanism, to allow multiple knowledge applications to access multiple facts data bases. This approach to knowledge independence offers the advantage of permitting data sharing (really knowledge sharing) among applications
>
> [Berry & Cook 1982:495]

Formal design processes are employed to achieve this separation [Date 1985, Zwart & Love 1983] but this may not be always possible when dealing with continuous data, e.g.

> many areas of natural resource data are either difficult to classify, or cannot be classified, because classification is dependent upon the use to which the data is put.
>
> [ALIC 1990b:10]

Enforcing separate functional and data (entity–relationship) model prescriptions on to certain types of observation may therefore create artifices of little use or resemblance to the real world, especially, as will be argued later, in the policy domain. Other computer data representations, like object-oriented models that combine function and data, offer some potential to alleviate these difficulties. As they are now constructed, however, most land information systems will not be able to process functionally dependent data without introducing distortions and additional uncertainty. There are alternative constructs that may be used to maintain some functional dependencies in the data and which potentially would improve the usefulness of land information systems in the public decision making process. These will be commented on in Chapter 9.

Summary

Systems with the characteristics and features that have been described are emerging globally. While at present some may only serve as a resource for a single organisation, are less than comprehensive or are directed at a limited range of tasks, this is more a reflection of their stage of development than any inability to conform to these criteria. As Niemann and Sullivan [1987] observe,

> the deficiencies which speakers identified relevant to GIS functionality related primarily to institutional structures, rather than to GIS technology per se, such as data structures or algorithms. A common complaint centred on the project by project nature of GIS activities they were authorised to conduct, as opposed to having a specific authorisation to become involved in a day to day, routine spatial data management functions.

Organisational and institutional difficulties have beset land information systems since their inception for a complex mix of social, economic and political reasons [Zwart 1981]. These reasons, and the prescriptions for their solution, are now well documented [e.g. AURISA 1985:17-32, Dale & McLaughlin 1988:183-186]. Given the considerable progress that has been made, particularly in Australia [AURISA 1985; ALIC 1990] and in parts of North America, plus the proliferation of new systems in recent years, it is suggested that, once the data management and availability issues have been resolved, systems of the type described will become commonplace by the turn of the century. There is considerable evidence that this is already happening [Zwart 1991c]. As ALIC [1988:3] notes in its document "Benefits of Land Information":

> Computerised land data bases are being established in a wide range of government agencies with the statutory authority to administer land or with planning or regulatory responsibilities. However a feature of the new LIS will be increased sharing and exchange of data amongst and between all levels of government. The ultimate aim is to make land information readily available to all users in the community.

A community that has access to systems of this type will then have at its disposal:

1. A spatially referenced inventory of integrated data about such things as land tenure, ownership, land use, soils, geology, water resources. This

data will be held in its most basic, discrete form, grouped into themes or subjects according to a predefined data base schema.

2. Data in the inventory will have been selected, described and maintained in compliance with predetermined standards of nomenclature and classification. Within these specifications data will "have form, but no intrinsic content ... and follow certain rules to convey the content intended by the creator" [Bedard 1986:50].

3. A range of spatial manipulation and analysis tools by which to re-format, restructure and combine data to produce virtually an unlimited range of spatially referenced data products and models.

4. A means by which to portray the data, "to communicate the content of information" to the intended user of the data [Bedard 1986:50].

5. A system by which to link, view and manipulate socio-economic and physical data as an integrated entity.

In short, what will be available is an organised, managed resource of spatially related information consisting of discrete, geographically referenced data items conforming in content and form to a set of rules capable of being manipulated by a range of users to deliver information for some particular purpose.

Yet, at the same time as indicated in the last section, such an information resource will have a number of inherent shortcomings that may limit its applicability, usefulness or relevance for some applications. First amongst these limitations is the land information systems data model. Its reliance on being able to hold data spatially, temporally and by subject in small discrete, elemental packages, immediately presupposes that the uncertainty the information is intended to relieve can be addressed in the same manner, i.e. by the addition of small packages of functionally independent information delivered and used according to a known schema. *Prima facie* this will present difficulties in the public policy process affecting land; a process that inherently does not conform to algorithmically definable processes. It involves values and contextual meanings, which are primarily concerned with making sense out of randomly organised and incomplete (mis)information – items which are almost exclusively outside the land information system data model.

Secondly, while spatial manipulation and analysis functions of geographic information systems (GIS) are both extensive and flexible, they are also narrowly focused: they are in the main restricted to the spatial domain. The modelling of spatial interaction may be highly significant for some tasks and some problems, such as transportation modelling, but they may provide few benefits or insights for describing public issues or for the modelling of (say) socio-economic systems or processes such as consumer preferences or incomes – factors just as important as, if not more important than, spatial location and distribution in understanding (say) urban systems or planning proposals.

Thirdly, land information systems in their broadest network form are essentially a collection of distinct, separately evolved systems, designed, with few exceptions, to fulfil a specific administrative, management or planning role. This view of the world, this norm, however, may not be appropriate or applicable to other users, in or out of the network The reconciliation of these essentially separate systems into a common resource is only now being attempted. It is still unclear at this stage what sort of a model these networked systems will represent, how useful they will be, in what context and for what purposes.

The root cause of these potential shortcomings is that land information systems are essentially functionally rational systems, that is, systems that are built for a predetermined purpose, which need to be scientifically consistent in their operations and are predicated on a means–end form of reasoning (Appendix A2). The broader question, therefore, is: how suited are systems based on this premise for addressing the planning and policy issues to which many would like to believe land information systems should be applied?

This question will be examined in detail in later chapters, where it will be argued that systems with features such as those described above are of limited use in the policy process and need to be augemented for that purpose. In the meantime, an examination of the reasons for establishing these systems – and why many people link these systems, largely unthinkingly and uncritically, to policy making and "better" decision making – may assist in addressing these factors later.

CHAPTER 3

LAND INFORMATION SYSTEMS – THEIR PURPOSE

> Formalised information technologies are not as self-evidently beneficial as technicians presume.
>
> Keen [1981]

Introduction

Systems with features of the kind described in the last chapter began to become technically feasible in the mid 1970s and are being gradually introduced as a response to two main concerns.

The first of these, and perhaps the more general, is the perception that the problems besetting society in general and our land in particular are becoming more complex, more intractable; in short, are out of control. One response has been to attempt to manage this complexity through the adoption of more systematic, comprehensive and effective planning methods backed by the provision of consistent, integrated and complete data and information about our land. Hence as Dale and McLaughlin [1988:14] note, "the gradual introduction of formal, systematic planning techniques, has focused attention on the need for new strategies and procedures for gathering, administering, analysing and disseminating land-related information."

The second, related concern is seen to be the complexity of managing the rapidly increasing volume of accessible, but poorly organised, and at times contradictory, land information to support the desired planning and policy setting activities. This, coupled to a recognition by government that traditional land management practices are costly, inefficient and largely ineffective, is leading to the introduction of land information systems in their own right, independent of any planning or policy requirements .

Part of the solution to overcoming these two problems, and in turn the larger policy and planning concerns, is to view land information as a resource – a strategic weapon – to enable government to take a corporate view of the problem of land information management by building "the infrastructure of a land information system to act as a concentrator and disseminator of information to others" [Humphries 1984:11].

Over the last decade or more these concerns have developed into what may be termed the land information system imperatives, the *raison d'être* used world wide for their implementation. I suggest, however, that in the implementation process these imperatives have become confused and interwoven to such an extent that the ills and benefits of each are ascribed to the other. As a result, many land information system proponents are crediting land information systems with powers and benefits in the planning and policy fields that are largely unsustainable and not borne out in practice. How and why this may have come about is the subject of this chapter.

Concerns Leading to the Introduction of Land Information Systems

LAND INFORMATION SYSTEMS AND PLANNING

The demand for more and better information about our land resources stems from a number of diverse causes, high amongst which is an enduring desire to improve the planning process and its outcomes through increasing certainty of choice about the future, by the addition of readily available information and formal analysis procedures. This urge towards attaining certainty in planning is not new, and its emphases vary only with the prevailing paradigm or mode of planning, be it comprehensive, procedural, incremental, social or pragmatic [Batty 1991, Healey et al. 1982]. What *is* new, however, is our ability, since the early 1970s to integrate and manipulate large amounts of formal data and information about our land resource, its use and conservation, through the introduction of computer based storage and modelling techniques.

Societal Complexity

In part, the introduction of procedural planning practices based on general systems theory in the 1970s rested directly on the availability of these systems and the spectacular success that system theory and analysis in general were enjoying in the scientific and engineering fields [House & Schull 1988: 214]. At the same time there was a persistent perception that the problems facing society were growing more intractable, their frequency increasing and their solutions becoming less obvious – in short, that society and its problems were becoming harder to control and order. Systematic, computer based modelling and analysis seemed to offer the promise of the way to shaping better policy and planning decisions. Without them governments at all levels, when dealing with these kinds of problems, seemed to be, as Bolan [1975:1] noted, "paralysed and unequal to any sort of effective response" with directed goals no longer being achieved confidently or gracefully, resulting in dissatisfaction with proposed actions, or complaints about the effectiveness of programmes and waste of money.

As a response to exerting this control, public policy decisions were conceived to be rational procedures with this "rational" ethos backed by government through a preference for technocratic and scientific solutions leading to optimal decisions. After all, the notion that something is out of control, too complex to be understood or managed, is a foreign concept to Western cultures:

> we believe that control is possible, and that we must strive for it. As a both necessary and noble aspect of Western self-identity, we strive to isolate the variable conditions of the environment and manipulate them for our own advantage.
>
> [Winner 1977:19]

The approach adopted is typified by Chadwick [1971:xi] in the introduction to his book "A Systems View of Planning".

> This book sets out to be a theory of the process known as town and regional planning. It is a theory of a special kind in that it is based upon a broader theory: that of General Systems and is allied to the field of Cybernetics.

In this model of planning, cities and regions were taken to be complex systems whose structure could be understood in terms of hierarchies of sub-systems, the operations of which could be modelled and programmed to reflect the dynamic framework and equilibrium of society. It became the era "when the complexity of the city in terms of the physical impact of social and economic processes was realised and embodied in the systems approach" [Batty 1991].

Man was considered to be an "optimising animal" accustomed to thinking in terms of sets of causal relationships derived from logic and functionally rational models through the analysis of objective, scientifically verifiable data. Rational procedures were introduced, both to create a rigorous understanding of problems and to provide a means by which optimal decisions could be "logically deduced from such an understanding" [Breheny 1984]. For example, when US Senator Hubert Humphrey, a fervent advocate of planning as a means of social reform, introduced the Rangeland Resources Planning Act 1974 in an attempt to avert the paralysis that public controversy was bringing to the US Forest Service planning, he stated that

> The goal of this legislation is to reform the way short- and long-term decisions are made by providing a comprehensive factual basis for all who have to participate in the process... The subsequent budget process each year will benefit because we will be dealing with facts rather than fantasies and emotions
>
> [Quoted in Healy & Ascher 1990]

This combined the ideas of means to a defined end, a best solution, and a rigorous, scientifically reasoned "true" process producing true answers. Planning was to become "an attempt to interpret scientific theory, culled from other fields, to the professional planner, whether practitioner or student" [Chadwick 1971:xi]. The approach was based in part on the notion that the influence of human beings on their world outside themselves had reached a point in the post-industrial societies where our lives are much more influenced by human activities and (hopefully) by human reason rather than by the natural order of things. Hence it follows

> as a consequence of the kind of life that is influenced much more by human activity than by nature outside of man that one has to plan more. If things happen independently of what you do, there is not much point in planning, and you just adjust to the way things happen. On the other hand, if a lot of what happens depends very much on what you do, what your friends and neighbours do, and what the rest of the world does, then planning is evidently much more important.
>
> [Feinberg 1975:42]

Rational, scientifically based policy determinations were seen as a way of imposing control, a tool by which to perfect this planning through optimising some variable or property, such as utility or equity. Planning would ideally rest on systems having both the data and the requisite optimisation functions readily accessible.

> In this context then, planning embraced system models and these models were, in turn, regarded as embracing the information systems useful in making them operational.
>
> [Harris & Batty 1992 :10].

Hence the response to handling increasing complexity was as Western and Wilson [1977:xiii] note "an ever-increasing demand for information to cope with it and for plans and strategies that will suggest the direction future developments should take."

Urban and regional planning information systems and their genera were therefore seen to be an integral part of the planning process, a process seen as relating information, model and planning system in a sequence of: description and understanding; survey and information system design and system modelling for alternate plan formation and evaluation – system characteristics and functionality closely resembling those of the land information systems described in the previous chapter. The link between planning, in its broadest sense, and computer based information systems, like land information systems, become firmly established. Land information systems were clearly in tune with governments' faith in the planning procedures of the day.

Land Information Systems and System Planning

The key elements in this approach were, of course, information and knowledge, information to be analysed to isolate and identify problems, knowledge and information for forecasting and modelling potential changes, for formulating and evaluating appropriate policy choices, to monitor deviations from policy and as a means by which to recognise new public issues. To this end, and in parallel with the establishment of operational research procedures and management information systems in the bureaucracy, new land information systems for planning and monitoring activities were established such as the Canadian Geographic Information System (CGIS) for land-use change, and the Minnesota Land Information System [Craig 1985] for rural planning and the USAC project to provide local government information systems for urban governments [Kraemer & King 1979].

The last mentioned programme, USAC (Urban Information Systems Inter Agency Committee), started in 1970, was perhaps one of the best known attempts to improve local government planning, management and operations. It was founded on the philosophy that the best way to gain these improvements was to increase the use of computers and automatic information systems so that

> they could be used in an analysis and redesign of municipal goals and activities; they could integrate data and data processing, creating a dynamic data base for use in planning, management and integration of local operations.

The thrust of these information systems, and many to date, rested

> on a series of assumptions concerning the role of information in policy decision making processes – in particular the assumptions that a systematic approach to the collection, organisation and analysis of information will contribute to effective policy decision making.
> [Barrett & Masters 1985:3]

In this environment, computer based information systems and their use symbolised rationality and control [Danziger et al. 1982]. Yet, as experience with IMIS (Integrated Municipal Information System – the program implemented under USAC) indicates, this assumption did not hold up. Hemmens [1975:12] found that none of the local government units trying to develop indicator or evaluation systems for policy analysis, long term planning and budgeting felt that the IMIS, including all the data operations of their departments that might eventually be included in the system, would or could provide the information needed. Kindleberger and Topping [1992] go further and suggest the USAC programme "to have been at best a failure and, in the eyes of some, a rip off".

The reality of systems practice and the difficulty of developing appropriate system models to reflect planning and policy task [Brewer 1973, Batty 1991] proved to be somewhat different to the operational and theoretical ideals on which these systems were founded. As these practical limitations of this "technology" approach became apparent, planning and policy concerns were also changing.

Planning came to be concerned with smaller scale issues, with political conflict, with advocacy, bargaining and negotiation as the emphasis shifted to resolving social issues directly rather than indirectly through the physical urban infrastructure. Notwithstanding these shifts, as will be demonstrated later in this chapter, the literature suggests that many in the land information systems community have failed to recognise these changes and continue to justify the establishment and use of land information systems in these procedural policy and planning terms.

THE DEMISE OF SYSTEM PLANNING

In general these early planning systems failed to live up to expectations, with the initial enthusiasm for computer modelling and planning quickly disappearing. Inexperienced, poor management, unreliable and incomplete data plus unrealistic expectations as to how, and how quickly, these automatic systems of land information could be implemented were part of the cause. More fundamentally, these procedures overwhelmingly focused on the means of planning, rather than the ends, and without such ends and defined choices they flounder [Hambleton 1986]. In particular, from a land information systems point of view, the assumption that operational and administrative data could be use for planning if only it was re-organised and integrated proved to be too simplistic and premature. It is only now, a decade and a half later, that this has started to become a genuine political, organisational and technical possibility, as illustrated by systems like NRIC and ERIN [CEPA 1992] in Australia. Hence, statements like those of Humphries [1984:10] that "All the information necessary for efficient planning exists but is largely inaccessible" proved to be wrong for anything but the most simple and prescriptive planning operation. As a result, some systems failed and others were modified, while a few survived, such as the Canadian Geographic Information System [Gelinas 1984] and the Minnesota Land Information System [Craig 1985].

These "technical" system and data problems, while contributing to the general demise of many of the planning systems towards the end of the 1970s, corresponded with the general demise of the technocratic, prescriptive policy making procedures in favour of approaches concentrating less on long term strategy issues and more on foreground and short term management and local concerns [Forester 1982, Breheny 1984, Batty 1988]. Formal information and analysis were still to be employed but now as an aid – another input, not as the centre piece of planning methodology and process.

In this more reflective mood, it was also recognised that human reasoning is influenced by social conditions and their resultant assumptions and beliefs as much as, if not more than, by scientific fact and abstract reasoning. This required the use of substantive, as opposed to functional rational, methodologies (Appendix A2) to modify the clinical impartiality of the scientific method to a social context. The strict means–ends relationship of analysing problems, forecasting outcomes and designing solutions resting on explicit, prescribed information sources could no longer be supported or ideologically sustained.

Hence, as Breheny [1984] argues, the intended relationship between information and policy formulation that was openly stated and generally understood had been broken, yet in the information systems field there was no heart searching or rejustification, even though "one might reasonably have expected the revolution in the policy and planning fields to have affected the information field, to have forced it to rethink and justify a fresh approach to its work."

Breheny makes this point from the perspective of a planner. What he perhaps failed to realise or acknowledge is that land information systems were being established for reasons other than to support planning and policy activities. Nevertheless a reassessment, as Breheny suggested, might have alerted the land information community to the tenuous relationship that was developing between it and land-related policy and planning processes.

STRATEGIC MANAGEMENT AND POLICY LEARNING

The collapse of the procedural/system approach to planning resulted in an inevitable backlash against analytical, comprehensive models of physical planning in favour of practices involving enterprise based, local rather than strategic issues of development and social welfare. At the same time a vacuum created in strategic planning methodology had by the end of the 1980s in the words of Batty [1991] "come to a strange, somewhat confused mixture of paradigms, styles and approaches" with little closure to a number of different viewpoints. It was however almost universally accepted that positive intervention by planners should be replaced with the planner as a facilitator, and that the influence of technology and "scientific methods" should be restricted to providing data, information, development control and automation and not be concerned with forecasting, modelling and the design of strategic plans as in the procedural period. As a result, the use of land information systems in physical planning has now been largely confined to dedicated, narrowly focused mapping and modelling applications, usually on individual desktop computer systems (Chapter 2).

The abandonment of rational models of strategic planning caused a similar hiatus in strategic management and policy thinking and a re-evaluation of methods. This has led to the gap being filled, in both strategic management and policy implementation by a number of 'schools' or theories largely derived from the shortcomings of and the lessons learned from the earlier system methods [e.g. Mintzberg 1990, Ingram 1990]. Significant for the purpose of this study are the lessons that:

- The emphasis should be on policy process, rather than on policy outcomes.

- The emphasis should be on policy learning by linking policy formulation and implementation through evaluation.

- The emphasis should be on managing bottom-up approaches which are iterative, but disputative and seek opportunities for strategic alliances between those involved.

In short, both strategic management and policy implementation point to "the need for a flexible, iterative process, supported by structures which allow maximum participation and discussion" [Davis & Weller 1993] and to methods, as Mintzberg [1991] suggests, where strategy (policy) is conceived informally before being programmed formally.

Models of policy and strategic management processes based on these and related ideas have been proposed but as yet have received little practical use [Lindblom 1979, Sabatier 1987, 1988]. Should policy processes of this kind prove to be efficacious in the real world, then, as Davis and Weller [1993] propose, they are likely to offer a considerable improvement in managing the land management policy area over more conventional and now disreputable processes. It should also mean, as proposed in Chapter 7, that the role of land information systems in the policy process is likely to be more overt and hence measurable.

Land Information Systems and Land Management

The maintenance of an unquestioned link between land information systems, policy and planning processes may, in large measure, be defended on the grounds that at the same time as systematic and procedural planning practices were falling into disrepute, there was also a rising public interest in conservation issues in general, and the use and allocation of the land resource in particular. As Smith [1990] notes about the forest debate in Victoria,

> During the 1970s the economic use of community resources became more and more controversial as voluntary organisations developed the professional and technical skills which allowed them to make their own assessments of the effects of industry using State-owned resources for private profit ... The results of these assessments were that this would have serious negative consequences for native flora and fauna, and air and water quality.

For the land began to be seen as being under stress due to the negative impact of human abuse of the land's use, its value and its capability [Environment Canada 1983:5]. As a result there emerged a realisation that the land, be it as a storehouse of fuels and minerals or as a sense of place or as a commodity, needed to be maintained and nurtured to overcome the environmental, social, political ills of the past.

In many ways, as Bowman [1979:5] suggests, physical planning and this "new" concern with environmental management, despite some fundamental differences in starting points and values, overlap both in process and substance. Each being future-oriented and problem-centred aims to avoid future difficulties and reduce those already evident. Each is subject to the constraints of the public policy making process and each has elements that are attractive to a rational means–end problem solving approach. Coupling this with the fact that information on land, its properties and location was an essential element in both resolution processes, it followed that land information systems were seen as being able to play a pivotal role in the planning, use and husbandry of the land.

This call for improved environmental and conservation policies as Epstein [1988:10] notes has corresponded with significant advances in (land) information technology which together

> offer the opportunity to improve policy and implementation decisions based upon access to reliable, accurate, timely and available data and information.

Similar views have been espoused by, for example, McLaughlin [1982], Nijkamp and Solomon [1986:91], and Alexander and Hart [1987]. These authors, in line with the previous comments about societal pressure to "control" our circumstance, emphasise the growing intervention of the state in the land management process, and the need for controls to be supported by "new strategies and procedures for gathering, analysing and disseminating land information" [McLaughlin 1982]. They view the implementation and effective use of a land information system as a key ingredient in managing these complex environmental and land resource based issues.

This drive towards better management (or control) of our land resource is being accomplished by what some have termed a cultural and value change towards an emerging land ethic, where "we see ourselves no longer as the powerful manipulators of all else, but merely a member of a community that encompasses soils, waters, plants, animals, and man and his respect for the other members" [Akillian 1975:24].

A synthesis of such an ethical framework with the technological tool of land information systems, operating within an ever "greening" political environment, seems to some to offer a powerful aid to addressing certain of our current ills; on the premise that the data driving the system is available, is of the right kind and delivered in the appropriate form and in acceptable time frames.

What, by and large, is not being acknowledged is that planning and policy concerns now tend to be more pragmatic; that smaller-scale, local rather than large-scale strategic issues are the dominant current planning and policy interests. The emphasis has shifted towards specific, enterprise and development concerns such as resource management, facility location, or transportation, as against the broad strategic issues that were the chief concern of the procedural planning era. The emphasis has shifted away from grand policy to resolving short term, local and discrete technical or social issues.

The developments in land information systems' functionality and cost reductions have to some extent matched this trend, resulting in a swift expansion of the introduction and use of land information systems for tasks ranging from specific planning tools [Newton et al. 1988, Dueker 1992] to simple data classification and analysis systems on a spatial basis [Forrest 1990]. These applications, however, tend to be well defined tasks and decision processes. There is little or no evidence that these systems are making any contribution to policy formulation, for example, as envisaged in earlier times.

Land information systems, however, continue to be viewed as having a much wider utility – as a tool for addressing much larger social issues than the narrow task-specific systems applications for which they are presently being employed. In part, this belief that land information systems are a significant technology in addressing broader societal ills rests, as Lord Chorley notes in the British Committee of Enquiry into Handling Geographic Information, "on the simple fact that most human activities, and many aspects of government decision making depend on ... knowing where things are and understanding how they relate to each other"

[Chorley 1987:7]. It appears that this feature of being able to store, manipulate and relate objects, be they physical, social, economic or environmental, on the basis of location is at the heart of this continuing belief that land information systems have a wider social utility than most other information system technologies.

Thus, by their very nature, land information systems may well continue to be associated with attempts to ameliorate the worse affects of rapid social and technological change on the well-being of our land, irrespective of the prevailing mode of planning and despite serious technical and philosophical doubts about its suitability for this purpose [e.g. Openshaw 1990, Harris & Batty 1992, Zwart 1992]. It is therefore not surprising, for example, that the team undertaking the systems analysis study for the South Australian Digital Cadastral Data Base (DCDB) saw the need for a land information system to respond "rapidly to an ever increasing rate of change in an increasingly complex institutional and social milieu" as an ever more pressing issue. Apparently the South Australian Government also thought so when they supported the recommendations [DCDB Project Team 1983]. Hence, calls like those of Weir supporting the introduction of land information systems, albeit on the basis of some specific elements of these systems, will continue to be made.

> Comprehensive information on land capability, characteristics, tenure, use, and legislation should be collected and continuously updated so that all citizens and levels of government can be assisted in determining the most beneficial land use allocation and control. Thus, land-related information becomes increasingly important to the orderly, fair, and intelligent use and development of the land.
>
> [Weir 1984:1]

After all, as Massam [1980:68] argues, in urban and regional planning the spatial component is the dominant element.

LAND INFORMATION SYSTEMS AND INTEGRATION

One additional reason for the perceived link between land information systems and higher level planning processes needs to be examined. Land information systems, through their ability to reconcile, verify and combine at times disparate data, are seen as an integrating technology – as a means of obtaining a complete, "holistic" view of an issue rather than a piece-meal, reductionist breakdown necessitated by other more conventional approaches to land information management.

Traditionally our land resource, and the information relating to it, has not been viewed or managed as a totality, but rather as a collection of discrete, largely independent components – mining, soil, forestry, urban development, transportation, water and irrigation, and so on. Institutions responsible for managing each of these "components" of land, collect and manage their own separate, supporting information systems to fulfil their designated tasks. Conventional land management and land information practices may be viewed, therefore, as being vertically organised, as distinct and separate tasks contrasting with the integrated, horizontally organised arrangements that are necessary to manage our land as a simple entity [Clapp & Niemann 1977].

Pressure for information on land to be organised and managed in its entirety is likely to be maintained as "the-whole-of-land" agencies such as Departments of Urban Affairs or Environmental Protection Agencies continue to expand in numbers and statutory significance. These organisations generally operate within integrated, broad-scope strategies that manage physical growth or redevelopment with social and economic planning. Their information needs transgress traditional land management and land information administrative arrangements, requiring not only different kinds of information but also much of the existing information to be differently organised, accessed and portrayed. Conceptually, land information systems should be able to meet many of these needs and, by extension, the broader aims. "If this were to happen we would then be nearer to finding a way of reconciling the pressure on the environment with the environment's inherent limitations" [O'Connor 1978].

Many continue to suggest, therefore, that perhaps it is not so much the case that the information may not be available, but rather of making sure that all the available information is arranged in a form where it could be utilised in the relevant decision making process – i.e. in an integrated, organised and managed collection. Senator Gerry Jones, chairman of the Senate Standing Committee on Science, Technology and the Environment enquiring into land-use policy, comments that "of all the resources that will need to be shared if a more coordinated national approach to land use is to succeed probably the most important is *information*" [Jones 1984] (emphasis in the original). In a similar vein, the Forum of Land Ministers in July 1992 agreed, amongst other things, that "Integrated land information can contribute significantly to effective informed decision making on the management of land and property resources" and that it "remains as the only way all individual elements can be brought together and observed" [Forum 1992].

Seemingly, land information systems are being increasingly seen as an integral part of the solution for improving our land and environmental management practices. Yet, despite this rhetoric, there are few reported cases of how land information systems are contributing "significantly to effective informed decision making", let alone for anything other than well structured problems (Appendix C5). Their role in public planning and policy setting for land or environmental management appears to be still largely an article of faith, as much now as when the rational, procedural mode of planning was in vogue. I postulated that much of this faith stems from the considerable success that land information systems, of all varieties, are enjoying through the operational gains they are achieving at the managerial level. These gains are helping to continue to perpetuate over-enthusiastic claims about the place of land information systems in the planning and policy processes. How this is occurring is the topic of the next two sections.

Operational Efficiency and Effectiveness

Breheny's [1984] concern (quoted earlier in this chapter) with the lack of a critical review by the information community following the falling out of favour of functionally rational planning practices, rests on the premise that the policy and planning fields gave birth to land information systems in the late 1960s. While this may have been the position in the U.K. and to a lesser extent in North America, this was not the case in other countries, including Australia, where no significant information system developments occurred during this period. Nevertheless, the nexus between information and policy decision making that Breheny highlights is valuable in that it establishes, in part, the roots of the continuing belief that information emanating from land information systems will lead to better public policy decisions.

As Ottens [1990:20] observes, the distinction between the functionality for spatial planning on the one hand, and for increasing the efficiency and effectiveness of organisations for spatial management on the other, is crucial when assessing the usefulness of land information systems in urban and regional planning. This is particularly so in Australia where by the time serious efforts were commenced to establish land information systems in the late 1970s, scientific, rational planning processes were out of fashion, having been replaced by the pragmatic, economic rationalist policies favouring benefit/cost studies, improved efficiency and operational effectiveness as justification for creating information systems. As a result, system development was concentrated in the land administration arena at the operational level where cost savings were more readily demonstrated; where tasks are well defined and understood, e.g. South Australia [Sedunary 1977], Victoria [State Coordination Council Victoria 1979] and Western Australia [PA Consultants 1979].

In keeping with this new rationale, system implementation became subject to detailed justification stressing operational efficiency gains through faster access times, reduced record sizes, and lower staff costs. Most also made some reference to better information for planning or decision making, but only in passing, not as a central need or as the justification for introducing these systems. Potential gains in organisational efficiency and effectiveness through improved land information management practices became (and are) sufficient reason in their own right to introduce some form of land information system.

IMPROVED INFORMATION MANAGEMENT EFFICIENCY

The main thrust of land information systems over the last decade has been to respond to pressures in the public sector to reduce costs, improve services, and become more accountable for decisions taken.

Typical of this trend towards enhanced organisational efficiency and effectiveness are the objectives of the various state administrations in establishing integrated land information systems. New South Wales, for example, set the overall aims for its system to

> – generate administrative efficiency and cost reduction by rationalising the management of basic land records
>
> – help maximise productivity in public sector agencies through more effective and efficient use of land records
>
> – improve land-related data availability ...
>
> – increase government revenue by the marketing of innovative land information ...
>
> [Alexander & Hart 1987]

Justice Kirby, of the Australian Law Reform Commission [1984:39], in his address to the National Conference on Better Land Related Information for Policy Decision, commented that if useful results could follow from the conference, "the cost savings and national utility" that will be secured and the efficiencies that will be promoted "would far exceed his achievements while chairman of the Law Reform Commission". This is in line with Moore's suggestion that "the pursuit of such savings should be the first priority of a land information system" [1987].

Establishing an integrated land information system is now seen to be a major contribution to achieving such operational efficiencies through the positive changes they bring to the collection, storage and retrieval of land-related data. In general, there are a number of different ways to measure efficiency gains [Ackoff et al. 1962:34-36] of which two, minimising the inputs of personnel, time, equipment and money required, and maximising the increase of services or products on the output side, are typical.

Land information systems are being justified on both grounds. For example the special task group in Victoria [State Coordination Council Victoria 1979:2] examining the introduction of computer based land information systems found

> that there was a need for a land-based information system that would achieve:
>
> (a) removal of existing redundancy and duplication in data collection and error correction;
>
> (b) facilitation of the flow of information between departments, authorities and local government;
>
> (c) data collection by the agency best placed and most dependent on the timeliness and reliability of this data;
>
> (d) reduction of the cost of providing certificates of restriction ...
>
> (e) provision of systematically updated cadastral map base of the state ...

This and similar studies in North America [NRC 1980:21], in Western Australia [PA Consulting Services 1979:87] and at the Australian Federal level [Jones 1984:25] emphasise variously the efficiency gains to be achieved through reduced duplication in collection and storage by the use of compatible indices and identifiers and by linking of data between agencies. They highlight that intra-government cooperation and an adherence to data custodial arrangements and data standards will not only reduce costs for data collection, storage and retrieval, but will also improve staff productivity and provide opportunities for additional revenue [ALIC 1990:2].

While few formal system or programme evaluations have been reported to measure the actual as opposed to the anticipated benefits, they are being achieved [e.g. Marwick 1988 (Appendix C5)]. Moreover, they are being achieved by large numbers of disparate organisations across a wide spectrum of applications. Describing a decade of experience on the use of an integrated land information system in a US city (Milwaukee) for tasks ranging from evaluating proposed zoning changes to managing city resources, Huxhold [1988] records that these systems have shown they

> are more than drafting and engineering tools. When combined with existing administrative records, with appropriate links into mapping data bases, geographic (land) information systems are effective management and planning tools as well. They have shown that geographic information systems have benefits in virtually all functions of city government.

In nearly all cases, including the tasks described by Huxhold, what is being referred to are operational level, well-defined, goal directed activities amenable to functionally rational process (Appendix A2) leading to verifiable, optimised solutions. These conditions normally do not apply when determining planning outcomes or policy options (Chapters 4 to 6).

<u>Computerisation Gains</u>

It is also arguable whether a significant proportion of the operational gains being derived from using land information systems stem from the mere fact that the systems are computer based. The flexibility that digital data offers over manual based systems in terms of data structures, data representation, spatial referencing, transmission rates and physical volumes, leads to major efficiency gains through, for example, reduced search times and savings in space [LISSC 1982b:5]. These benefits also extend to the digital spatial (map) domain; e.g. "... an essential attribute of an efficient land information system is the ability to relate, and inter-relate its data geographically" [DCDB Project Team 1983]. Yet it is a moot point whether other benefits attributed to the introduction of a land information system, such as improved accuracy, retrieval times and data currency, flow chiefly from the fact that the data is in digital form, or are substantially due to the considerable effort that has to be expended to reorganise data rigorously – that is, improvements "fostered by the demands of computers for consistent data" [Kraemer et al. 1981:52]. As has been suggested elsewhere [Zwart 1989], it appears that many of the efficiency gains commonly procured by employing a land information system through restructured data and data flows, alternative collection processes and administrative changes to land information management procedures, may be also obtained without resorting to the use of a computer, particularly during the early stages of implementation. This proposition and how it could be used to improve the acceptance of land information systems products will be examined further in Chapter 9. In the longer term, however, it appears that the reorganisation and conceptualisation of the data as a common shared resource, rather than merely the "computerisation" of the data, will bring about the major overall system and organisation-wide operational efficiencies [ALIC 1990].

Reduced Planning Role

Irrespective of the mechanism that brings about the improvements in the data processing, there is now a substantial body of evidence to indicate that land information systems, when employed for operational tasks, enable users to acquire reliable information about the portions of the earth of interest to them in less time and at less cost.

There is also a substantive body of evidence to indicate that, in practice, the accentuation of organisational and procedural benefits of land information systems, rather than their links to land-use or planning policy, will continue in the medium to short term. As the review of the developments in planning in the UK, in Barrett and Leather [1984:14], points out

> Over the past fifteen years there has been a change in emphasis from seeing computer based information systems as supporting and enhancing the analysis and understanding of the environment acted on by planning, to seeing computer systems as a means of increasing the efficiency and effectiveness of the organisation.

Similar supporting comments have been made by Batty [1988:337], Kraemer [1981:54] and Moore [1987]. Moore comments that "for strong pragmatic reasons" the first objective should be to gain some of the efficiencies that "the processing of information pertaining to land in a coordinated manner" can provide, leaving the delivery of "broad policy/planning goods at reasonable cost and quality" until gains in the operational areas have been attained. This ordering of priorities – that is, improving the efficiency of an essentially traditional "product" or service before addressing new objectives – is in keeping with the experiences of introducing other new technologies into established institutions [e.g. Coates & Finn 1979].

Justifying the introduction of land information systems through the automation of existing tasks has become the prevailing norm for introducing land information technology into an organisation. The adoption of alternative, substitute procedures and extended applications based on the new possibilities offered by this technology, in our case to influence public policies about land, tend to follow later [Newton et al. 1990]. Whether this could happen, and under what conditions, will be developed in Chapters 9 and 10. It is likely, however, that the mere fact that the information is better organised, more readily available and more reliable, despite common wisdom, will be of only a marginal advantage.

OPERATIONAL EFFECTIVENESS

While the quest for operational efficiency has been a major factor to date in motivating organisations to introduce a land information system, particularly at the administrative level (e.g. land titles, valuation, taxes), closely coupled to this drive to minimising resources and maximising output has been a pressure to improve the quality, reliability and range of services offered by agencies concerned with the administration, management, planning of our land.

This pressure to upgrade services, as commented on earlier, stems from a perceived need by society to reassert "control" of its environment, its political and economic destiny. As a result, there is increasing social demand for accountability in operational and planning decisions that is affecting all levels of governments and most land-based activities. In part, this need to be able to support and justify intentions or actions rests on the availability of good information or better information than is obtainable from traditionally structured land information records.

Reforming existing recording systems to deliver rapid, precise and reasoned responses to public questions is seen as one step towards attaining greater credibility for proposed actions and plans . Consequently, an ability to provide this "better" information for planning and operational use "is seen as an important objective of an integrated land information system" [PA Consulting Services 1979:19] or, as Johnston [1983] notes in the context of local government,

> While land information forms the "bread and butter" of parts of each organisation it is increasingly needed as a tool for broader use, capable of benefiting the community as a whole.

Changing information management practices by the introduction of a land information system with the characteristics described in the previous chapter is, therefore, seen as promoting organisational effectiveness, be it, as for one electricity authority, by the "simple, accurate, location of customer premises" [LRIS 1976:61], or, as in the case of the Commonwealth Government to improve "the information base for commonwealth decision making processes relating to natural resource management issues". This was to be achieved by establishing a national resource information centre [NRIC 1989] in recognition of the fact that

> an agreed, common and accurate information base of the basic resource and environmental parameters of the area under discussion would assist in both the commencement of interactions and defuse some of the potential differences in attitude.

In each instance, it is intended that the "improved" information available from a land information system should increase the effectiveness of the proposed action by reducing the associated uncertainty (Appendix A3) and the time taken to select that particular course of action. Ideally, restricting the number of alternatives considered on the grounds of lack of time or the costs involved to compile the required information, should no longer be necessary or be a critical issue. Providing these improvements extend across the spatial, topical and temporal domains, then the efficiency of having a comprehensive, integrated and reliable resource of information on land is seen by some to lead, *ipso facto*, to more effective problem solving [e.g. Carter 1979:106].

Achieving such benefits, like the efficiency gains discussed earlier, will largely depend on the suitability or otherwise of the rational, means–end model as a description of the task or process at hand [Clapp et al. 1989]. As will be argued in later chapters, when decisions are goal directed, as they are for most operational tasks, there is now well documented evidence to indicate that positive efficiency benefits are being achieved (Appendix C4). The evidence for assigning similar efficiency benefits from improved information management at the policy and higher planning levels, however, is scarce and debatable. As instanced by the quotations above, some such benefits are being attributed for some, though largely unspecified, planning operations. Until these are identified it will be difficult to describe with any certainty the actual as opposed to the perceived contribution made by land information systems to these tasks.

Efficiency, Effectiveness and Planning

Taken together, it is perhaps ironical that much of the information sought by the earlier procedural mode of planning is now becoming available through the improved land information management practices introduced to achieve operational efficiency and effectiveness. This in turn contributes, in part, to the belief that there is a connection between land information systems and the policy and planning processes.

What is being suggested *de facto* is that the land information systems at the administrative and operational levels contain data, and possess capabilities, that are intrinsically useful in "decision making", including the substantively rational, open-end processes associated with resolving public issues like land-use or resource allocation. This belief builds on the assumption that the use of land information systems in decision making is by definition good (Chapter 1) and accords with the notion of information as a resource, in this instance on land, being suitable for a multiplicity of situations by a wide constituency of users (Chapter 2). It is, therefore, once more being proposed that it is feasible to develop (or use existing) systems:

(a) to support aspects of planning and policy setting;

(b) that contribute to the strategic levels of decision making through setting and evaluating public goals and,

(c) that influence public decision making processes and outcomes.

Consequently, in part due to the earlier links with programme planning, and now through the possibilities being opened up by the new land information management structures, pronouncements that land information systems are "an aid to decision making" [Chorley 1988:20] and increase the likelihood "that accurate decisions will be made" [Weshe 1986] continue to be made. Statements of this type are supported by the formation of an organisation such as the Commonwealth Government's National Resource Information Centre (NRIC), established to upgrade the information base for decision making processes for resolving natural resource management issues [NRIC 1989]. Together with two complementary information systems, the National Forest Inventory (NFI) and ERIN (Environmental Resource Information Network), NRIC draws on, upgrades and supplements environmental information it obtains from operations and management data bases held by each of the Australian states [AACLI 1989].

These systems are designed to fill much the same role as some of the earlier planning systems, such as the Canadian Geographic Information System (CGIS) established by the Canadian Federal Government in 1971. It is used, amongst other things, "to collect, analyse, and provide land-use change data for lands directorates, for the public, and researchers, and to policy and decision makers at the various levels of government" [Gelinas 1984]. The technical difference between the Australian and the Canadian systems is that NRIC essentially assembles and combines the data routinely gathered by the states for their own management and planning tasks, whereas CGIS essentially collects its own data for its own specific purposes. The Australian federal systems could not exist without the systems established by the states primarily to achieve efficiencies and to be more effective at the operational level.

It is perhaps not surprising therefore that, at least for some, "decision making" has once more become the *raison d'état* for land information systems.

> Land information systems will ultimately be measured by the impact it [they] will have on assisting both the government and the private sectors in their decision making processes.
>
> [Rogers 1989]

It has become beholden on the land information community "to increase the awareness in all jurisdictions of the importance of the use of land information for decision making" [ALIC 1988], and to uphold the paradigm that "better decisions will result from better information" [Niemann et al. 1987, Wellar & Harris 1992].

The real, tangible benefits of improved efficiency and effectiveness achieved by land information systems at the operational levels are being credited to, and transcribed into, the decision making and problem solving arenas; unqualified and with little evidence to support the claim. Such claims linking land information systems with decision making concerning aspects of land may not be unreasonable for certain types of decision making, for example "ordinary policy making" as in the deliberation over substantive policy choices within a *given* structure or context of what people want and how policies are legitimately made [Healy & Ascher 1990], or for certain kinds of applications, for instance the physical rather than socio-economic aspects of land (as will be discussed in Chapter 9). But to extend this assertion to all problem solving across the decision making spectrum (Table 1.2) and to all application areas without apparent restriction or exception seems to be, despite its intellectual appeal, without any real foundation – a delusory non-starter [Wellar 1990].

Summary

Land information systems are being introduced as a response to two societal goals. The first is to achieve efficiency in the management of information as part of a demand for improved productivity in the public sector – which, as Moore [1987] notes, is not a passing phase. The second is the urge to master the perceived complexity of contemporary society by controlling change through better planning, particularly as it affects the environment and the physical well-being of our land.

The land information community and many in the general community see the first goal supporting the second. They believe that, much as in the days of systems planning, the availability of "better" operational level information, more efficiently delivered and effective in its scope and quality will *prima facie* assist and enhance the policy process. They hold that, in keeping with other kinds of improved information management systems that increasing the frequency with which information can be produced, improving its technical quality, reducing its age, and improving the timeliness with which it is made available, self-evidently benefits the policy and planning processes [Kraemer et al. 1981:219].

As noted, the pursuit of operational efficiency and effectiveness in land information management has become the dominant issue in recent years, and has justified the establishment of many of the land information systems created today. Even though few, if any, formal evaluation studies have been undertaken to compare system performance with system justification (which given the generous public expenditure on these systems is perhaps somewhat surprising), extensive anecdotal evidence suggests that perceived benefits are :

1. Gains in operational efficiencies through improved location, more consistent data and reliable linkage devices in land administration tasks such as title searching and land valuation.

2. The provision of better information for the formulation and selection of alternatives in land-use planning and facility location.

3. Multiple use of the same data for routine, management and monitoring tasks.

[Zwart 1988] (Appendix C4)

Even though these findings relate to Australian land information systems, and were based on largely anecdotal, rather than quantitative, evidence, they are supported by numerous reports world wide, as the earlier citations from the USA, Canada and the UK [e.g. Chorley 1988, England 1985] indicated.

As a result, there is now a general acceptance that the use of land information systems is a good thing at the administrative, operational and management levels where problems and decision outcomes are well defined. While there may be a similar consensus amongst sections of the land information systems community that this goodness is extendible to the planning and policy arenas there is little evidence to support such a proposition. The changes to physical planning processes away from systematic, rational and prescriptive procedures represents a general move by government to more flexible and pragmatic methods of planning. These changes apply equally, if not more so, to the generally contentious issue of land management and the environment. The role that formally structured and presented information does, or could, play in this situation, where neither the problem, the goal, nor outcomes are known, as is the norm in the resolution of public land-related issues, remains a poorly researched and little understood topic. It will remain just an article of faith until an assessment is made of the nexus, if any, between land information system and land policy and planning, as Breheny suggested. With land information systems now becoming an accepted and integral part of some organisations' corporate information technology [Zwart 1992], it is perhaps an appropriate time to attempt such an overdue assessment.

For the purpose of this study, therefore, we will take the gains in operational efficiency and effectiveness as given, and concentrate on examining what influence the improved land information products and services – that is, the "better" information – has on land management at the policy levels of government.

To do this, as the discussion on rationality in Appendix A2 shows, land information systems will need to be viewed from a broader perspective than just the narrow, scientific and functionally rational one favoured in the current literature. It will need to recognise that society looks to land information systems as it does to science as a whole, to provide relief and assistance for many of its ills. At the same time this assistance will have to be within the limits established by the prevailing norms and the capabilities of science. A notion of functional rationality cannot, therefore, be sustained in practice, and must be modified to accept the irrational external control exercised by the prevailing social conditions and their concomitant political, moral and ethical values. This in turn implies a departure from a strict means–ends approach to problem solving towards an acceptance of the notion of substantive rationality – an acceptance that factors outside those encompassed by land information systems and the scientific method have intrinsic effects on the fulfilment of society's goals and aspirations.

The question therefore becomes one of identifying and qualifying the role that formal, structured information systems with extensive analytical and modelling capabilities have in a subjective value-laden, pragmatic environment as opposed to the imagined clinical, intellectual and factual world of science. It is also a question of how well land information systems can adapt, can become relevant and meaningful in a world where "reason is and ought only to be the slave of the passions" [Bertrand Russell].

The technology at our disposal, the data that are becoming available and the collective experience gained over the last two decades, now place the land information systems community in a position where it could provide systems and information that *prima facie* assist public policy decisions concerning land management and planning issues. Not much is known, however, about the nature of this contribution, as to when and how information from computerised systems affect the public policy process or its outcome. It *is* known that the demand for data from land information systems is high; yet as Gelinas [1984] notes "it is difficult to assess the level to which the data are used by decision makers." Without wishing to minimise the difficulties involved, the balance of this thesis will attempt just such an assessment by examining the problem solving and decision making processes, in both the private and public sectors, from an information use perspective; to identify conditions under which formally structured information resources like land information systems could influence the public decision making process.

PART B

Information, Problem Solving and Public Policy

CHAPTER 4

PROBLEM SOLVING

> All empirical science is an elaborate structure built on piles that are anchored, not on bedrock as is commonly supposed, but on the shifting sands of fallible human judgement, conjecture and intuition.
>
> Joseph Weizenbaum

Introduction

In the last chapter it was suggested that many in the land information systems community have been failing to acknowledge that the benefits brought to land-related operational and management tasks by their systems may not be extendable to the strategic planning and policy arenas. Such an extension may have been valid as long as the emphasis remained on the physical environment, on system theory and on procedural planning practices, but there is little evidence that today's concern for balance between social and economic interests is tied either conceptually or methodologically – to the ready availability of comprehensive sources of (land) information. This is partly because, at least theoretically if perhaps not in practice, previously the strategic policy and planning process and the information systems backing it were founded on the same rational, cybernetic model. Today only the information systems use this model as a basis.

For the land information systems community to continue to assert that it can support or supplant decision making in the policy process implicitly suggests that the designers of these systems understand the way the public policy process operates under these "new" conditions. The evidence from the land information system literature to date, however, suggests that there is little appreciation of the process involved (refer Table 1.2). Therefore, in searching for means by which to identify how land information may be employed in the policy process, and perhaps for ways in which to extend their utility, a number of different theories of how human beings formulate policies, and make decisions, need to be reviewed. More explicitly, and more to the point of this thesis, such a review may also help us to understand that policy makers, for a variety of reasons, do not always see information and analytical techniques as useful to the policy process. In many such situations, no amount of refinement or juggling with land information system techniques to make them "better" would change their perceived utility to the decision maker.

Land information systems, with few exceptions, are presently being used by *government* agencies, at the management and operational levels, to assist in making public *decisions* about land-related matters. As land is an all-pervading entity, the application and extent of the use of these systems has grown to be extensive indeed (Table 1.1). In each case, however, in reaching their decisions, government officials have to be cognisant of, and work within, a set of guidelines or policies which have previously been determined at some higher strategic or political level. Working within a predetermined policy framework is one task, but using land information systems in the framework's formulation is another.

Up to now, as the land information systems literature indicates all of the experience gained in the use of land information systems, and all of the recorded benefits, have been with *ordinary* problem solving, and not with the process of devising and selecting the public policy framework within which these problems are solved. These latter activities represent *strategic* problem solving tasks. For example, there are national and regional programmes in place for conservation and resource management in the UK and New Zealand in the implementation of which land information systems are playing an important and prominent role [Rideout & Holbrook 1991; Walsh & McQuoid 1991]. There is no evidence to suggest how, or to what extent, land information systems influenced the policy process that decided what the policy was to be and how it was to be implemented.

If land information systems are to have a regular place in the public policy process, then as a first step we need to clearly distinguish between what is involved in ordinary problem solving, what the public policy process involves, and how decisions are "made" in each. To do this simply, we will initially examine problem solving and decision making under the condition that both are directed processes, subject to the control typically exercised by departmental heads in the public and private sectors. These are the conditions under which, for problem solving, land information systems are known to be making a contribution and which remove, for the moment, the political factors that so dominate the public policy process. Once the function and place of land information systems in these "controlled" processes have been clarified, the role of land information systems in the public policy process can be explored. By following this path we will be gradually moving from an area where we know a lot about how land information systems interact with the decision process to one where we know little, but where many believe, *a priori*, that land information systems should be of benefit.

Throughout, the approach will be one of attempting to explain what advantage the ready access to systems possessing the properties of land information systems (Chapter 2) offers decision makers. In this chapter the reason for, and the purpose of, the problem solving process will be briefly examined, and the part that formal information plays will be described. This will be followed in the next chapter (Chapter 5) by a similar study of the decision making process. The last two chapters in this section will look at the public policy making process – including the way in which policy options are formulated and preferred policy positions determined – and the possible place of land information systems in these activities.

This and the following chapters therefore serve as a reference by which to begin gauging what land information systems actually do, or could potentially do, in the public policy making process. It also begins to identify those aspects and characteristics of land information systems that tend to contribute positively to these problem solving processes, and those that are likely to lead to their rejection. That will suggest changes that may improve land information systems' usefulness and acceptance.

Problem Solving Models

To begin, a decision process will be taken to be "a set of actions and dynamic factors that begins with the identification of a stimulus for action and ends with the specific commitment to action" [Mintzberg et al. 1976:246]. In the prescriptive literature on problem solving, the course of action is usually conceived of as a sequence of steps within a number of recursive stages, each stage being thought of as a component problem or a decision cycle in its own right.

In the most generic psychological sense, problem solving represents a binary stimulus-and-response cycle where a stimulus from within or without threatens the internal state of equilibrium. This triggers a "need" to react; to do something to restore the balance [Havelock 1977:49]. The question then arises, what needs to be done to alleviate the problem and what actions need to be taken to achieve this end.

Simon [1977] extends this basic binary cycle by searching for stimuli (conditions) in the environment likely to cause a problem. This is his intelligence state. He then proceeds to a design stage where possible responses (courses of action) are developed and analysed. A choice stage is included to select, from among the actions developed, the one deemed to satisfy the need. These three stages may be fleshed out further by separating the "specification of alternative stage" from a "choice (decision) stage" and by allowing for a "correction and supplementation stage", i.e. a feedback loop to monitor the results of the decision [Mack 1971:137].

These models of problem solving portray the classical, rational or scientific process of solving problems wherein the first activity is to define the problem, the secondis to select the means or process to be used for the solution, and the third is to identify those state(s) or ends that appear to represent an acceptable or optimal solution. As the discussion illustrates, interpretations of how problems are solved vary with respect to the process, to the stages in the process, their sequencing and their relationships between stages. Each, nonetheless, represents an ideal or prescriptive form of problem solving, perhaps of limited practical value, but valuable as a framework within which to analyse and describe the general decision process. For this reason, the next chapter will construct a number of models of land information systems as a problem solving system, based on similar normative assumptions, to illustrate how information may be used in each case.

It should be noted that the descriptive value of any of these stages or "phase theorem" models of problem solving may be limited. For example, as will be discussed in Chapter 6, we cannot help developing alternatives concurrent with our information gathering activities - cannot "avoid evaluating these alternatives immediately" [Witte 1972, quoted by Mintzberg et al. 1979]. Similarly, new information often causes the decision maker to face a redefined challenge which abbreviates these five stages; or there may be more than one stimulus leading to more than one problem forcing the decision maker to not only define what will form a satisfactory solution (goal setting), finding and designing the suitable courses of actions but also to choose which problems or issues will be attended to. Most environmental and land-use problems tend to fall into this multi-faceted category but have in the past been treated as one-off single issues.

Problem Solving: A Brief Outline

For the moment, however, we will clearly distinguish between problem definition and decision making (as this is one of the main roots of the confusion about the place of land information systems has in the public policy processes). They will be considered as discrete activities. It is recognised that this ideal or prescriptive form does not normally translate into reality, for as Inbar notes the "aims affect the decision-making process, and problems encountered while it unfolds in turn affect aims" [1979:18].

A number of authors, e.g. Mintzberg et al. [1976] and Dery [1984], have grouped the problem identification and goal setting stages together and referred to them as *problem definition.* Selecting alternative courses of action and *decision making*, that is, evaluating and choosing the preferred action, are treated as two other activities. Grouping the problem solving activities in this manner to emphasise the separation of problem definition from the formulation of alternatives from choosing, helps, as will be demonstrated in the next chapter, to define the possible place of land information systems in the public policy process.

If we take the Resource Management Act (1991) by way of example, the policy component comprises the New Zealand government selecting the problem of balancing development and environmental safeguards, defining its goals as "managing the use, development, and protection of natural and physical resources in a way, ...", and declaring the Act. How the local authorities, for instance, are to fulfil their obligation under the Act to monitor the state of the whole or part of the environment of their areas is their problem solving component. Part of the local authorities' problem solving activities will be the preparatory steps of identifying and selecting an implementation strategy, i.e. setting the goals, and designing the alternative activities to be considered in the choice (decision making) stage. For example, the Act provides for waters to be classified as a tool in a management of water quality. In recognition of potential problems created by biological growth in rivers, lakes and estuaries, the Act specifies that "there shall be no undesirable biological growth as a result of any discharge of a contaminant into the water." To implement this standard to comply with the recommended guidelines, local authorities will need to scope the issues, set objectives, develop performance standards, and establish development controls. A monitoring function will be required as a part of each of these activities. These activities are the problem-solving steps necessary for each authority to manage the implementation of the policies laid down in the Act.

PROBLEM DEFINITION

Like decision models in general, most prescriptive models of problem solving picture the three steps – problem definition, selection and goal setting – as a sequence of recursive steps within and between stages: a selective trial-and-error search within a defined "problem space" or a generate-and-test heuristic [Newell & Simon 1972:428]. The difficulty in problem solving is then to identify the maze, the branches of the decision tree or the heuristic that yields the correct path to an *a priori* defined terminus. Hence "the process of problem definition will be one of search, creation, and initial examination of ideas for solution" until a problem has been converted to a decision problem [Dery 1984:26]. At the same time, this activity also has to be cognisant of a number of environmental factors, both internal and external, that provide behaviour-constraining mechanisms through which only certain specific actions or movements may become possible or acceptable.

Identifying these constraints and searching for ideas depends on having available the required knowledge and sources of information by which to acquire this knowledge. *Prima facie* it therefore appears that land information systems may be able to contribute to the problem solving process.

PROBLEM IDENTIFICATION AND FORMULATION

Problem identification and formulation, as part of the intelligence phase, is conceptually defined as identifying and describing the nature of a problem that needs to be addressed. What is considered to be a problem, however, is open to a number of interpretations.

First, a problem may simply be considered as a state of difficulty or some undesired state from which relief is sought. In this definition, little may be known about the desired state; all that is known is that the present state is unacceptable. In public policy making it is often, as discussed in Chapter

1, a case of moving away from something that is undesirable, rather than moving towards some set goal.

A second and more common definition of a problem is as a difference – a difference between an existing, undesirable situation and some future desired state. In this instance, there might be some ideal or model of what is desired which is selected by the decision maker. This is then compared with the present state of affairs, the differences are identified, and a view formed as to whether they are causing some difficulty or a problem that needs to be alleviated.

Lastly, a problem may be considered as an opportunity for improvement: that is, even though the present state may be acceptable, it appears possible to attain a better state if certain actions are taken. (A more detailed discussion on problems and how they may be viewed is given in Appendix A4.)

These alternative perspectives on what comprises a problem highlight the fact that problems are contingent on person, situation, and event. They occur within a particular context, rather than being absolute entities in their own right. So they may be subject to change and fluctuations as their context alters over time and with circumstance. For example, during the last two decades changing social expectations have dramatically changed the nature of the problems of land-use or exploitation of natural resources [Healy & Ascher 1990]. In this situation, land information systems will need to be able to accommodate to such contextual and social variations if they are to be of assistance to the problem solving process. They will need to view problem solving as a continuous, dynamic activity rather than the static, one-shot operation implicit in much of today's land information systems literature. The dynamic factors will need to be addressed and incorporated in the data structures and operations if land information systems are to have a role in this type of problem solving.

In each instance, however, the existing and desired states have to be defined and a decision made as to whether there is a problem. Since land information systems are perceived to be an inventory as well as a modelling and forecasting tool (Chapter 1), providing they can respond to these fluctuating demands, then potentially they could be of some help in the problem solving process.

PROBLEM DEFINITION: SOME DIFFICULTIES

Methodological Difficulties

Problem identification and formulation need not necessarily be a formal or an explicit operation, yet it is the single most important part of the problem solving and decision making processes since it determines in large measure, however implicitly, all subsequent courses of action [Mintzberg et al. 1976:274]. Nevertheless, as Mintzberg et al. go on to suggest, this process is also the most neglected and least described activity in the literature on decision making [1976:254]. Hence, the introduction of land information systems into this process may face not only its own inherent limitations, but also a number of as yet unidentified descriptive and methodological difficulties.

These difficulties, as Widavsky writes in his foreword to Dery's book, while recognised, paradoxically persist.

> Everybody complains about the weather, the saying goes, but nobody does anything about it. The same could be said about the stipulation of problems in public policy. The great merit of this book is that it provides the *first* substantial and sophisticated analysis of how problems come to be defined.
>
> [Dery 1984:vii, emphasis added]

The cause, as Dery himself writes, is not that methodological contributions have failed to emphasise the importance of problem definition, but rather

> that the question of what is a problem – the process called problem definition and what one should expect to see at the end of this process – has escaped the policy-analysis agenda, with only few exceptions.
>
> [Dery 1984:2-3]

To some, the formulation of a problem is *the* problem, because

> the process of formulating the problem and of conceiving a solution (or resolution) are identical, since every specification of the problem is the specification of the direction in which a treatment is considered.
>
> [Rittel & Weber 1973:161]

The difficulty would therefore appear to be, in Inbar's terminology, that we are unable to separate goal setting from goal achieving, i.e. unable to distinguish between "the translation of aspirations and values into accepted social goals" and their implementation [1979:18]. This is due, in part, to our tendency, when confronted with a new issue, to be unable to move from question to problem to sense-making, or from specifying to connecting to orienting [MacMullin & Taylor 1984:93]. If we do act, the act is likely to be irrational, since "almost everyone takes it for granted that one cannot be rational about a problem without understanding it and ... understanding requires comprehensiveness of information and analysis" [Braybrooke & Lindblom 1963:40].

Because of these difficulties, and due to a lack of understanding about the contextual, factual and value influences, in many cases the process begins with a proposed solution [Pfiffner 1960:129] rather than with problem recognition or definition. A solution-before-problem-definition is a common means of resolving public policy problems, and (as will be discussed in Chapters 8 and 9) if land information systems are to be part of the policy process they may also need to have the capacity to operate in this solution-before-problem-definition mode.

The cause of this irrationality, Dery argues, is that we perceive problems as a framework for doing – i.e. the discrepancy view of problems (Appendix A4) – rather than as "a frame of reference which will aid us in making sense of our own actions, past and future" [1984:5]. In other words, we should use the problem as a reference for increasing our knowledge, acquiring more information and learning to make sense of our goals; in short, to gain an understanding of why a problem may exist as opposed to being primarily concerned with formulating an action on how to resolve it.

Quality of Definition

One additional aspect of problem definition needs to be considered if we are to gauge the potential of land information systems in this process. A consequence of not having a thorough or sufficiently complete understanding – of not being able to make sense of our proposed actions – is that we may end up formulating an incorrect problem and consequently solving the wrong problem. The resultant solution may choose the best alternative but "without necessarily considering alternatives that fall outside of a given definition of 'the' problem" [Dery 1984:31]. Or in Simon's behavioural terminology, "the ends to be attained by the choice of a particular behaviour alternative are often incompletely or incorrectly stated through failure to consider the alternative ends that could be reached by selection of another behaviour" [1977:65]. The decision may therefore be excellent and yet the original cause for the action, that is, the original problem, remains.

The quality of the problem definition then is important, for without this we may persistently be "shooting at wrong targets" [Barrett & Hill 1984:224]. Moreover, most feedback or evaluation will not uncover that the wrong problem has been selected as "we may learn via evaluation that certain means are ineffective, not that a certain definition of the problem and therefore the nature of the solution (programme) are inadequate" [Dery 1984:104]. Thus there are no "stopping rules" to the solution, "because there are no criteria for sufficient understanding and because there are no ends to the causal chains" [Rittel & Weber 1973:162] since the original problem remains unidentified and unresolved.

SUMMARY

Problem definition is not a trivial task, nor are its consequences insignificant. Prescriptively, once the problem has been defined there is no opportunity within the decision process to challenge its definition. Likewise, there is no other occasion to question the adequacy or otherwise of the ensuing maze (i.e. the group of alternatives from which to make a choice) as this falls outside the scope of the decision making process.

The key to achieving an adequate problem definition is to gain a sufficient understanding of the source and reasons leading to the problem plus the conditions that are *likely* to represent an satisfactory outcome. Gaining such an understanding requires, amongst other things, comprehensive knowledge, access to information and the means for its analysis and reporting – activities which are the *raison d'être* of land information system. Clearly, land information systems have an ability to supply and present information to assist with the clarification of the problem definition task, but there is little evidence of any substantial use for this purpose to date. The chance that it may do so in the future will be improved if, as is proposed in Chapters 7 and 9, land information systems follow Dery's suggestion; namely, that they abandon their focus on information systems as decision and action tools and concentrate on designing and implementing systems from a sense-making, insight/learning perspective. After all, problem definition is not a hard and fast decision process, but rather, a fact finding, wisdom seeking and learning activity.

Problem Design

Classic models of decision making, such as Simon's three stage process, follow the problem identification stage with a design stage for developing and analysing possible courses of action. This stage attempts, amongst other things, to limit the courses of action by laying down a number of strategies designed to achieve some specified goal(s); that is, the solution process is taken as seeking to satisfy some ultimate goal (problem resolution) by fulfilling a range of criteria laid down in a number of intermediary policies and statements of objectives.

In this hierarchy, *goals* are general end-points towards which individuals, organisations or society in general are striving. If achieved, they terminate the problem and the decision chain. *Objectives* are considered to be sets of sub-goals "that are both end- and staging-points" which are generally "held explicitly and actively worked towards" [Davis & Greenhalgh 1980:8]. *Policies* are taken to be the means by which ends (both goals and objectives) are achieved, through the identification of various *strategies*, these strategies encompassing "both policies to guide ways of acting" and "broad programmes of activities to pursue goals" [Anthony et al. 1984:4].

Rational models of decision making view each of the steps in problem design as a means–end chain of goal specification followed by the formulation of objectives, policies and strategies. From this perspective, for instance, the State of Vermont's *problem* of balancing land-use requirements with conflicting social and economic interests was "resolved" through a problem design phase that resulted in its Growth Management Act 1988. The law has the *goal* "to ensure the continuation of Vermont's character" through the *objective* of planned growth at the town, region and state agency level. Part of its *strategy* is the mandatory use of geographical information systems (GIS) for management and development under the Act. *Policies* defining priorities and potential applications for the state-wide GIS, procedures for data gathering, development of methods for providing information to regions and municipalities, and so on, are defined in the legislation [Healy 1990].

In general, the design phase may be viewed as bounding the solution space – as transforming an ill-defined problem into one that has, at least temporarily, if not permanently, a known structure and a stated end point.

In the case of Vermont, the Growth Management Act 1988 confines government agencies to planning growth at the town and regional levels, using information that is held in a particular form, on a state-wide networked GIS, implemented and developed by a set of prescribed policies. Other means of resolving the original problem have been ruled out as being inappropriate, other ways of employing and organising the state's GIS may not be supported.

The goals and policies defined by the problem definition activities, therefore, control the problem solving behaviour and process because only those policies (activities) directed towards obtaining these specified goals are consulted or useful. Hence, goals serve to reduce the degrees of freedom in the decision process, whereas policies propose courses of action consistent with the goals.

Goals and policies may therefore be viewed as control mechanisms by which organisation assures that people are guided in what they are supposed to do to attain the organisational goals and objectives [Anthony et al. 1984:9]. They may also be construed, in terms of decision making, as decision rules for lower level problems. The result is a decision making hierarchy in which the lower levels of organisations and society become "programmed" as both their outcomes (goals) and the process to be used are formulated in standard routines and procedures. In the words of Barrett and Hill, the policies become "routinised" into a day-by-day procedural framework for action [1984:222].

The steps of defining goals and objectives and implementing them by way of policies may consequentially be considered as transforming lower level decisions from ill-defined to defined through clearly stating, and distinguishing between, the ends to be reached and the means to be used. Accordingly, lower level decision processes have at least prescriptively (officially) their objectives deemed to be known. It is when this framework has been defined that land information systems yield the efficiency and effectiveness benefits detailed in the last chapter.

The difference between problems that have undergone a design phase and those that have not are crucial in understanding the contribution that land information systems could make in decision making processes. It is the essential, distinguishing feature differentiating administrative and management systems on the one hand and planning and policy making on the other. Land information systems have positive benefits for the former, but little direct evidence to suggest that they may benefit or influence the latter. Although in Vermont there were a number of personal and historical reasons for mandating the use of GIS [Healy 1990] as a *strategy for achieving* the government's goal, as in its counterpart in New Zealand (Resource Management Act 1991), there is nothing to suggest that land information systems were used, or contributed to the *design of the legislation*. Achieving defined goals and objectives, through defined strategies and policies, is usually taken to be a rational, means–end process paralleling the rationale and functionality of land information systems. On the other hand, problem design ultimately cannot be a rational process. The reasons for this are discussed below.

SELECTING GOALS

The notion that the selection of goals and policies could be conceived of as a "scientific", rational activity needs to be qualified. Firstly, in some instances there may be no choice at all, and only one outcome is possible. More generally, several goals are likely to be acceptable. The selection of one goal from many requires a decision through the exercise of judgement usually, but not always, comprising both factual (hard) data and ethical (value) propositions. Here factual data is used in the sense of testable statements about the observable world, even though the data to be used may not be fully authenticated because of the information and time available for reaching the decision (Appendix A1) . Yet, even when data used to derive a decision has been validated, decisions are only descriptions of *selected* future states of affairs.

Selection is an ethical or value judgement, not a technical issue, even when it is a technical problem. The problem of resource degradation in the Murray-Darling River basin (soil erosion, salinity, loss of natural flora and fauna, etc.) [Nanninga & Tane 1990] lends itself to technical solutions. Which technical solution to adopt, however, depends on which future agricultural, land-use and water management practices are favoured within some much broader economic and social context. In the end, the choice of practices that should be adopted as a part of the particular social and economic context remains a question of judgement, not technique.

How a goal or objective defines (or bounds) a problem is therefore largely a question of the balance between the factual and ethical contents of the problem design. Hence

> the further the means–ends chain is followed, i.e. the greater the ethical element, the more doubtful are the steps in the chain, and the greater is the element of judgement involved in determining what means will contribute to what ends.
>
> [Simon 1976:51]

The more the value content, the more difficult it may become to explicate the behaviour required to effect the goal, the means to achieve it and their separation. Hence, policies aimed at achieving goals and objectives that are predominantly the result of ethical or social questions are themselves largely ill-defined and inappropriate as means to terminate the decision process.

In turn, this makes it difficult to design, implement and operate information systems to support these ill-defined problems as their purpose; the data they should hold and the facilities they should provide are largely indeterminate. As a consequence, there is a limited use in the design phase for systems, such as land information systems, which concentrate on "value free" observable, and tested, data and algorithmic methods to process as well as present their information. This is not to say that these systems cannot at least provide information and analysis as input to bring about a more informed debate about which policies, which goals and which strategies could be adopted for the resolution of a particular problem. As Lam [1990] notes,

> when land and locational data become increasingly essential to policy consideration, GIS's spatial modelling and visual display functions are able to narrow gaps among different perspectives. Visualising the environmental impact from a zoning change or a new development proposal is an effective way of supporting people to structure future urban design priority and guidelines.

Even though Lam is referring to lower level policy, he is invoking the use of land information systems as an instructive rather than a decision making tool. It is this focus, this change towards becoming learning rather than decision systems, which is likely to maximise land information systems' contribution towards the strategic end of the decision process (Table 1.2).

However, a pattern of realism should be placed on the ultimate utility and influence that might be ascribed to land information systems for the problem design purpose. Sophisticated information systems and analytical techniques, no matter how they may be configured, cannot be a replacement for what usually has to be decided, in the end, through judgement and some political process, at all levels of the decision hierarchy.

Conclusions

Formal problem solving methods require the means and general end points by which identified problems may be eliminated to be defined. Establishing these goals and formulating such policies is considered to be an "unprogrammed" task invoked by stimuli that are often ambiguous and lead to responses which are essentially just "groping for a solution" [Mintzberg 1973:15]. In moving towards a solution, goals and policies have to be discovered and heuristic reduction processes employed until understanding contracts' complexity and uncertainty to the point where some initial strategies and solutions may be tried. Even though these "comprehension cycles" may be repeated numerous times, in the end the process of defining the goal, and hence achieving problem solving behaviour, essentially becomes a non-rational task, since finally the question of what to do still remains an article of faith and judgement, decided on a mix of social, ethical and factual grounds [Schlesinger 1963, March 1971]. It is in these unstructured, scientifically irrational surroundings that land information systems will need to establish their credentials, prove their worth and secure their credibility, if they are to be of any moment in the policy process.

It is also a world where, as March notes, it seems

> perfectly obvious that a description that assumes goals come first and action comes later is frequently radically wrong. Human choice behaviour is at least as much a process for discovering goals as for acting on them.
>
> [1971:573].

Present day land information systems, however, are premised on having at hand prescribed criteria to control and guide the work towards some explicit goal, by processes and procedures which themselves are defined and programmed. Fundamentally, they are not about acting as a vehicle for discovery and learning; they have difficulty where data has to be uncovered and connections made, where data are treated as unknowns, not givens, as is the norm in today's systems. While the coupling of decision support systems to land information systems overcomes some of the difficulties associated with using these systems in a discovery mode [e.g. Abel et al. 1991], they do not change the fundamental structure or operating principles as described in Chapter 2. The mismatch between a functionally rational system designed for ordinary problem solving and the need for a substantially non-rational problem solving process designed for policy processes remains.

To overcome this difference, as will be discussed in Chapter 9, the land information systems community needs to recognise that strategic problem solving is a question of understanding and judgement, based as much on preferences, intuition, prejudice and faith as on fact, while decision making is a question of deciding on well understood and defined choices. These may simply not exist. If land information systems are to make their presumed beneficial contribution to the policy process they will need to accommodate to the requirements of both.

Again, it must be stressed that, as presently constituted, land information systems do provide background data through their analysis and modelling capabilities [e.g. French & Belkap 1991], and do uncover relationships through mapping and displays for some strategic problem solving tasks under some circumstances [e.g. Steger & Bannister 1992]. It is just that there is nothing special about it; there is nothing to differentiate it from the other marginal contributions to strategic problem solving. Moreover, it falls far short of what the land information systems community assumes it to be.

CHAPTER 5

LAND INFORMATION SYSTEMS AND PROBLEM SOLVING

> Decision making requires thinking about the future and about subject matters outside one's area of expertise. Since one is most knowledgeable about past events in one's own field, only bold liberal thinkers will adopt comprehensive analysis voluntarily.
>
> House [1982]

Introduction

The last chapter proposed that land information systems, because they are premised on a functionally rational, means–end model of problem solving, may have only a marginal impact in the policy process as long as they fail to acknowledge that the latter process is, from such a rationalist perspective, essentially irrational. It was further proposed that land information systems need to seek ways to reflect this dichotomy in what they do and how they do it. One suggestion, to be further developed in Chapter 9, is to consider land information systems as instructional or learning systems rather than as systems for making decisions.

In this chapter the question of accommodating land information systems to the requirements of the policy process is taken one step further by examining, through a series of prescriptive models, the part land information systems could take in problem solving, from the routine to the strategic ends of the decision making spectrum (Chapter 1). The aim is to start identifying the kinds of land information system that might be more effective in the policy process in contrast to the types of system the land information system community is presently offering, and believes is required. The topics of the chapter are, therefore, information on the one hand, and problem solving in general on the other, as well as how these processes might be "arranged" such that the former (information) is of maximum benefit to the latter. The procedure used is one of deduction and comparison, deducing and comparing how land information systems interact with the decision making process and why, followed by how they could interact with the policy (problem solving) process.

The chapter will begin with some general comments on the functions of information and decision making. It then constructs four land information system based models of problem solving which are analysed and contrasted with existing land information systems to derive some broad prescriptive characteristics of land information systems to assist in the policy process. In the next chapter these prescriptive properties will in their turn be compared to the results of a number of behavioural descriptions of the policy process.

Information and Decision Making

Information, defined as the process of informing (Appendix A1), aims to change the state of knowledge about an object, event, concept, relationship, etc. The process may be viewed as an end in itself, as an educational or instructional process. It might also be viewed through the change it engenders, as generating more certainty or uncertainty about the extent, reliability, appropriateness, etc. of the present state of knowledge. In short, "The function of information is, among other things, to inform, to activate, to instruct, to provide precision, to generate ideas, to trigger the imagination, and to give pleasure" [MacMullin & Taylor 1984:108].

Of these functions, two are of primary interest: information as "... the removal of uncertainty" [Kochen 1975:5] and information in suggesting and learning [Churchman 1975:33]. The role of information in change, and as an agent of change, is also of some importance in understanding the relationship between land information systems and policy, and this will be taken up in Chapter 10.

There are numerous interpretations of what is meant by the term information (Appendix A1), but most take there to be a direct causal link between the presence or absence of information and the state of uncertainty. This is also the current view of most land information system practitioners.

Uncertainty may be defined as the difference between the amount of knowledge required to perform a task (decision) and the amount of knowledge already possessed. The basic effect of uncertainty is to limit the decision makers ability to plan or to make decisions about activities before their execution [Galbraith 1973:4], i.e. to fulfil predicted outcomes or, less kindly, prophecies [Argyris 1971:277]. The elimination of uncertainty represents the central task in decision making yet, paradoxically, without uncertainty there would be no choice; "in a world of certain relationships between ends and means there would be no real choice" [McGrew & Wilson 1982:5]. Decisions and decision making are therefore, by definition, choice under the condition of uncertainty.

Uncertainty is the complement of knowledge, and without changing the goal of the decision it can be eliminated only by obtaining a complete state of knowledge; that is, through certainty and a completely deterministic solution. For all but the simplest decisions, this is unobtainable. Thus, uncertainty is a necessary part of life, "as necessary as the air we breathe" [Mack 1971:3]. We learn to tolerate and adapt to uncertainty, as individuals and collectively, through minimising the risk and probability of the consequences of uncertainty by such mechanisms as over specifying, conservation and safeguards. A more complete description of the different kinds of uncertainty, its elimination or reduction, and how it affects the decision making process, is given in Appendix A3.

If we take knowledge (knowing) as being the result of an act of informing (information), then there is a direct link between information, certainty and hence decision making. It is in this sense that information produced by land information system is, and is seen to be, of value in the decision making process for the applications discussed in Chapter 3. The information held in the systems, the analysis they perform and the relationships they may reveal are designed to establish a higher level of certainty (or uncertainty), higher than is available without them. A higher level of certainty may be ascribed to the policies and goals (means and ends), as well as to the resolution of the original problem.

Where the problem remains undefined, information must of necessity act much more as an educational/instructional tool, because it cannot provide certainty for as-yet-unknown means and ends. It can perhaps only help to identify, clarify and explain the problem at hand and highlight possible ways for its resolution. This is in part the reason for suggesting, in the previous chapter, that if land information systems are to be of significance in the policy process they should be viewed in this educative role. The models of decision making outlined below look at information in both roles.

Land Information Systems as a Problem Solver

INTRODUCTION

To investigate how a land information system could serve as a problem solving system, it and the problem solving task will be separated into a number of components or stages. Problem solving is assumed to comprise six discrete stages in a means–end sequence of problem definition and decision making as described in the last chapter. The first four stages (problem definition) are: a *monitoring* component that monitors the external environment and the land information system to identify differences from a desired position; a *problem identification* component that identifies the causes and extent of a deviation from the desired position; a *goal setting* component; and a *design* function that defines possible solutions. The last two stages in decision making require, first, *an analysis and modelling* module, used to draw inferences and predictions from the data. These inferences have to be evaluated with regard to the problem identification and a course of action *chosen*.

The land information system is considered to have all the capabilities described in Chapter 2. Of primary interest is the *data* component holding the observations and recordings acquired as feedback from earlier *actions* and the external environment. The question to be explored in the models below (Figures 5.1 to 5.4) is whether a land information system, through the use of this data plus its monitoring, modelling and analysis components, could take over all or some of the decision making tasks, and if so, under what conditions.

With these components it is possible to construct four alternative approaches of land information system as a decision process, depending on which components are included in the land information system and which are under the decision maker's control. The four constructs are an inventory based system, a predictive information system, a decision making system and a decision taking information system corresponding to the heuristic, Bayesian, rational, and homo economicus decision models respectively detailed in Appendix A5. Between them these models cover the full decision making spectrum described in Chapter 1, and summarised in Figure 1.2.

If we include the problem definition activity as part of the decision maker's responsibility, then the model indicates how a land information would operate as a strategic problem solver. If, on the other hand, the problem definition task is taken as being completed inside the land information system – that is, it is a given – then the system and information corresponds to ordinary problem solving. These models may begin to suggest which parts of the policy process could or should be "assigned" to a land information system, and what should be left to the policy makers.

INVENTORY SYSTEM

This model (Figure 5.1) is the simplest approach, providing the weakest link between the land information system and the decision maker. The latter's task is to select the information for the problem from the land information system, evaluate its usefulness and incorporate it, or not, in the formulation and solution of the problem. Hence, the information system just acts to observe, classify and store information of potential use in the problem solving process.

This loosely coupled approach to information and decision making has one main advantage. It is most effective when the land information system is designed, as most are, to serve as a corporate resource for an open-ended, poorly defined constituency of users. The less that is known about the kind of problem, the type of analysis and the range of values and choices that the information needs to address – that is, the greater the uncertainty surrounding the relationship between information and the problem to be addressed – the more attractive this approach becomes. Since any combination or permutation of information items might be requested, and it is not possible to cater by programming for all, it is better to let the decision maker determine the requirements, rather than the information system.

Such an approach does not of course overcome the problem, as Shepard writes, of man having a remarkable capacity to collect, classify and combine vast amounts of information according to complex rules. But once the raw input has been

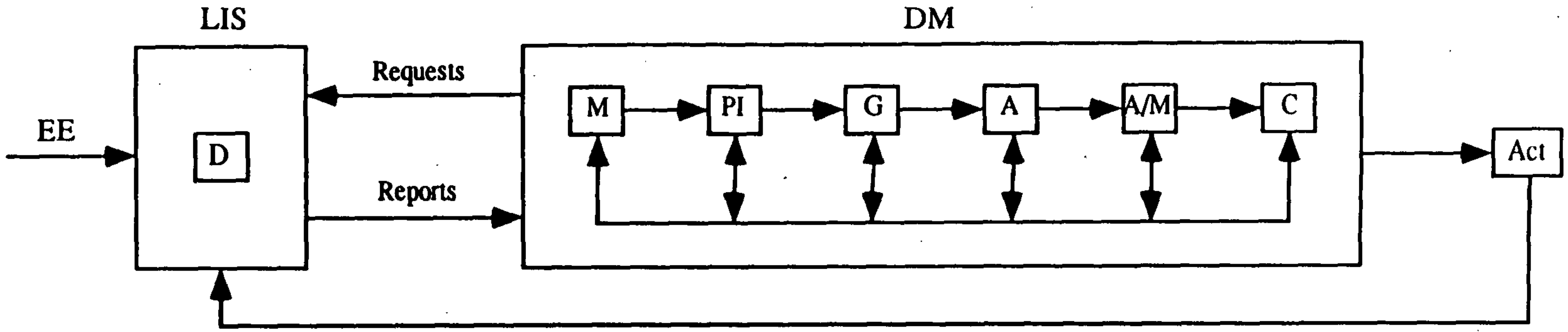


Figure 5.1 Inventory System

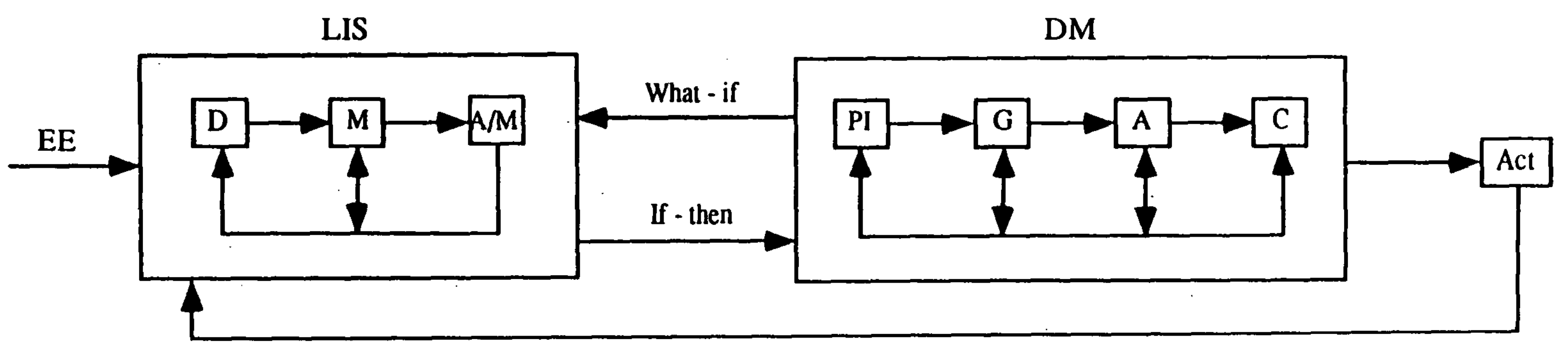


Figure 5.2 Predictive System

LIS	=	Land Information System	A/M	=	Analysis/Modelling	EE	=	External Environment
DM	=	Decision Maker	A	=	Alternatives	G	=	Goal(s)
ACT	=	Action	C	=	Choice	M	=	Monitoring
			D	=	Data	PI	=	Problem Identification

> reduced to a set of usefully invariant conceptual objects, properties, and attributes, ... [there is] little evidence that they can be in turn juggled and recombined with anything like this facility ... to arrive at an overall evaluation by weighing and combining or "trading off" all these separate attributes at the same time.
>
> [1964:257]

An inventory approach to using land information systems in problem solving process is most appropriate where decision making procedures are informal rather than prescriptive, where they rely on judgement rather than on quantification. Little can be said, however, about whether the decision maker uses the inventory and, if he does, how the information is used or what its subsequent impact is on the decision process or its outcomes. The heuristic and Bayesian decision models of Appendix A5 provide some indication of how the information may be used, but we will need to investigate some behavioural models to obtain an indication of how information is *actually* used if we are to gain a better appreciation of the role of land information systems in strategic (policy) problem solving. Such a model will be proposed in the next chapter to study this aspect in greater detail.

Militating against this approach are such factors as the failure of the information system and decision maker to communicate due to cognitive mismatches [e.g. Havelock 1975], differences in values and cultures [Caplan 1979] or in decision styles [e.g. Morris 1972]. More fundamentally, data may be either missing or in an inappropriate form, while the decision maker may not have the time, skill or inclination to extract the data. These factors will covered in Chapters 6 to 9.

PREDICTIVE SYSTEM

As noted in earlier chapters, land information systems may also be used as a monitoring and modelling tool. Hence, in the predictive information system depicted in Figure 5.2, the monitoring or recognition activities plus the analysis and modelling functions previously a part of the decision maker's activities are now considered to be a part of the land information systems task. The land information system, therefore, scans its data base for any discrepancies between the "is" and the "ought" states of a particular object or event. Similarly, the decision maker enquires "what-if", and the information system responds "if-then" using the modelling/prediction function of a land information system. No evaluation of either the problem or the outcome of the analysis is attempted by the information system; that is left to the decision maker.

Currently most land information systems are implemented using commercially available geographic information systems (GIS) software, which functionally has all the components of a predictive information system – a data input sub-system, a data storage and retrieval sub-system, a data and manipulation sub-system and a reporting sub-system [Burroughs 1986]. The in-built analysis and modelling capabilities are, however, strongly biased towards discrete, spatial and, to a lesser extent, temporal operations (Chapter 2). Consequently, these analysis and modelling functions have limited utility in the policy and planning process [Harris & Batty 1992] for land related, in contrast to land based, applications. These shortcomings may be reduced by combining existing land information systems with external modelling packages, such as those described in Newton et al. [1988], to cover a wider range of operations and tasks.

In this predictive model, the information system informs the decision maker what is predicted to happen under a predetermined set of circumstances, according to predefined rules. Within the capabilities of the information system, the decision maker may, of course, alter the conditions applying to the model, and thereby receive a different set of responses. However, ranking and evaluation of the outcomes against the aims and objectives (goals) stay with the decision maker.

This predictive model introduces more constraints than the inventory system, making it more structured and applicable to fewer problem classes. Specifically, it assumes that the monitoring of the environment for the presence or absence of an existing or potential problem, previously undertaken by the decision maker, can now be performed by the land information system by comparing the information it currently holds with the information it receives from the external environment. This implies that the land information system contains, and is able to hold, information of the type (that is, information required) to detect problems in the external environment. As will be noted in the next chapter, this assumption poses some real difficulties for using land information systems in the public policy process, even for land based issues.

A similar set of assumptions applies to the modelling and analysis ability of land information systems. Hence, the system has to set preconditions about relationships between data items, the functional form of the models, cause and effect relationships between various activities and transformations over the time–space domains. Predictive systems are therefore very successful when these parameters are well known to the programmer and the user, enabling the system to rapidly present either mathematically or spatially computed alternatives to the decision maker for consideration. When these conditions exist, the range and variety of tasks to which the land information system may be applied is extensive (Table 1.1), and information usage tends to be high. But, as noted earlier, the flexibility of the decision maker is reduced.

DECISION MAKING SYSTEMS

The next model (Figure 5.3) includes in the information system the criteria of choice, as well as the problem definition component – only the goal setting component of the problem definition activities remains outside of the information system. Decision making systems of this kind were the long range goal of many operational research proponents in the 1960s [Mason 1975] and more recently of the expert system communities [Winograd & Flores 1986]. The model needs to incorporate definitions of acceptable values and their measures, to rank choices, to determine preferences – in short a series of finite criteria by which to evaluate and select any desired outcome, whether that be the optimal, most cost effective, or otherwise most acceptable alternative. Therefore the range of values and choices – "decision rules" – need to be finite and generally amenable to algorithmic formulation.

There are usually no "rules" in public problem solving at the policy level, particularly about issues involving the development and use of land. They tend to be a social/economic, rather than a technical problem, even when technologically issues are involved (Chapter 6). As a first approximation at determining the extent to which land information systems can assist or "take over" the activities of the public policy process, we can say that land information systems based on the predictive information system may possibly contribute but those based on a decision making model are unlikely to do so.

Even though expert system technology is being applied widely, including expert system based land information system for natural resource management and land use planning [e.g. Smith et al. 1988, Abel et al.

1991], they are, as Winograd and Flores point out, still built on the assumption that the programmer can determine

> a small clear classification of relevant objects and properties together with a set of rules relating them. [Yet] there is no reason to believe that any future state of the art will transcend them.
>
> [1986:131].

The coupling of an expert system with a decision making land information system will, therefore, not add to its utility in the problem solving process as long as there is any part of the problem definition involved in the process. For this reason, the application of expert system technology will not be examined further in this context. Also, for the same reason, land information systems cannot have a *direct or instrumental* bearing on the problem solving processes where non-programmable and judgemental choice criteria are to be employed.

DECISION TAKING INFORMATION SYSTEM

The last model (Figure 5.4), a decision taking system, not only allows the land information system to select a solution but also allows it to initiate the resultant action. The model represents the classical homo economicus or rational view of decision making, where the decision maker knows both the means and the ends: that is, has a clearly defined problem, knows the alternatives he/she can choose from, his/her preferences for each, plus complete information on the utility of each alternative and its associated action. Thus, where it is possible to nominate an action to each defined choice, as is the case in well defined routine transactions, dealing with (for example) the transfer of land ownership, the total process may be programmed, since "the information system and the decision maker are one" [Mason 1975].

In this routine case, and in general, the goal(s) the system has to fulfil need to be imposed from outside the land information system. Their setting cannot be part of the system, otherwise it would be mathematically singular, offering an infinite number of goals and hence infinite choice and infinite action. *Any* formal information system that is designed to assist or support the decision maker can be only substantively rational; it cannot be divorced from the external environment (the organisation, the society) that supports it [Goldberg 1985:128]. Scientific or functional rationality can apply only to the decision making process, not to its aim (Appendix A2). The goal of a decision taking land information system is therefore

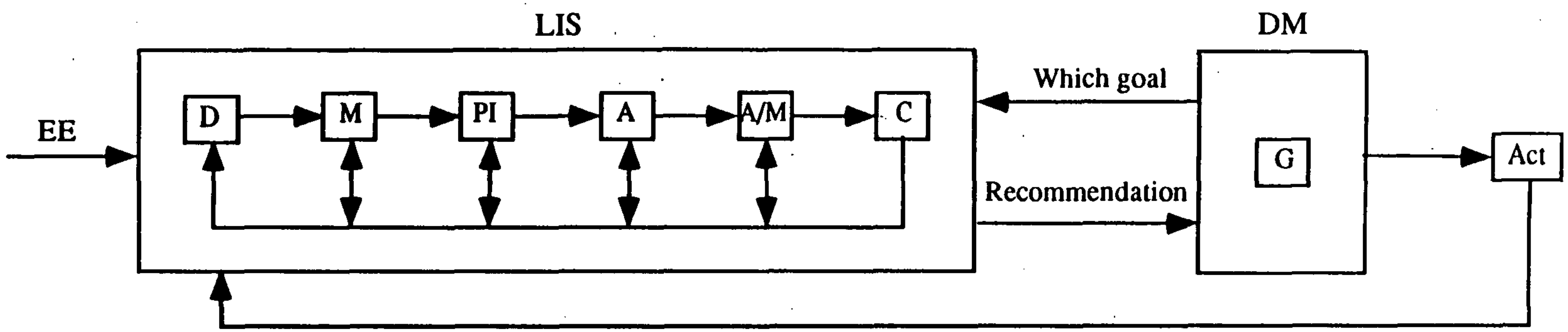


Figure 5.3 Decision Making System

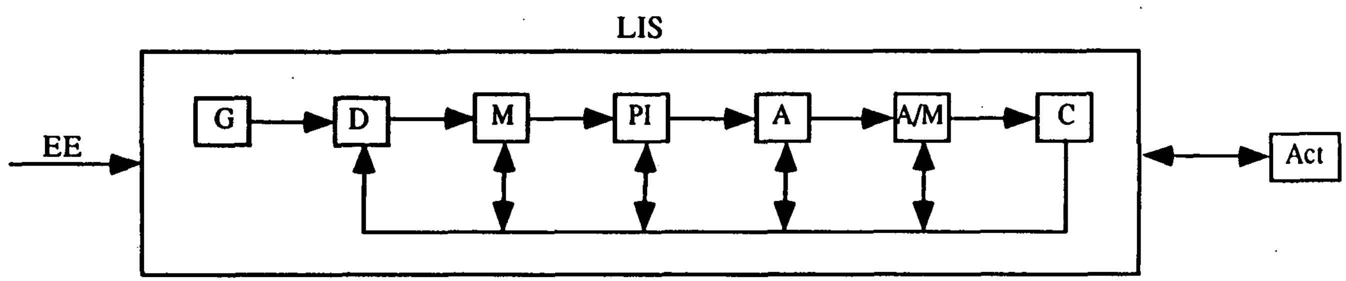


Figure 5.4 Decision Taking System

LIS	=	Land Information System	A/M	=	Analysis/Modelling	EE	=	External Environment
DM	=	Decision Maker	A	=	Alternatives	G	=	Goal(s)
ACT	=	Action	C	=	Choice	M	=	Monitoring
			D	=	Data	PI	=	Problem Identification

externally fixed and cannot be altered as part of the decision making process (Figure 5.4)

Land information systems therefore are not concerned with aims or goals (as discussed in the previous chapter), not only because they are the result of judgement, evaluation, and bargaining, but also because, as March [1971] notes,

> Goals are thrust upon the intelligent man. We ask that he act in the name of goals. We ask that he keep his goals consistent. We ask that his actions be oriented to his goals. But we do not concern ourselves with the origin of goals.

As the comments of Schlesinger quoted earlier and the analysis of information systems showed, determining goals or mix of goals is beyond the realm of scientific analysis and logic, and remains an article of faith and judgement. Land information systems cannot have a *direct or instrumental* bearing on the goal selection process. Given this, it is only an extension to pose the question, is the role that many ascribe to land information systems in public policy making also merely an article of faith or could they, do they, in some other way contribute to problem solving and public goal setting processes?

Discussion

The last two decision models (decision making and decision taking) represent the classic rational decision processes used by the procedural planning models discussed in Chapter 3. They involve the systematic analysis, the logical generation of alternatives, the systematic evaluation of these alternatives and a monitoring of the effects of the resultant actions. In each instance the process, the method and the criteria for obtaining an optimal/satisfying/acceptable solution are known and employed.

In these two models the information stored in the land information system, plus the environmental data, dominates the process with the problem solver's knowledge playing no part in the first model, and confined to selecting alternative courses of action in the second. Both of these functionally rational problem solving models lend themselves to programming, since the process to reach a decision is known, the goals to be achieved are defined, and the information required to solve the problem is at hand. These are also the characteristics of the applications in which land information systems are attaining the efficiency and effectiveness gains discussed: that is, in routine tasks such as issuing development permits, computer aided land valuation, the production of land titles, land slip prediction, flood plain delineation and so on. For these tasks, the decision process has well prescribed or developed rules that are stable and relatively easily modelled.

The decision-taking model, while not non-discretionary, confines the decision maker's choice, which in turn tends to make the choices repetitive, and hence easy to programme. Land information systems' contribution to the decision making process, as opposed to the data management process, could then be zero, as is suggested in Zwart [1986d], because the decision process itself is already defined and not influenced one way or the other by computerisation. The land information systems may improve the overall operational efficiency of a particular application, but not necessarily the decision itself. This is particularly so since, as was observed in Chapter 3, the efficiency benefits are due as much, if not more, to the reorganisation and conversion of the data to digital form as to any particular properties of a land information system.

The majority of the land information systems applications contained in Table 1.1 may be represented by decision making model. They typically involve an analysis and modelling operation to formulate and select preferred course of action in a well-defined process bounded by *a priori* goals established through a strategic problem solving activity. Route selection, urban land use planning and monitoring, growth forecasting and sales territory definition are typical examples of uses of land information systems conforming to this model. Having available in digital form a spatial reference inventory of data of known quality, capable of being digitally manipulated and displayed, makes for more efficient data manipulation and hence tends to increase the effectiveness of the decision making. Within the bounds set below, prescriptively, land information systems therefore satisfy the information needs, and the analytical functionality required, to effectively perform ordinary problem solving tasks.

The same cannot be said of the strategic/policy end of the decision making spectrum. Here, what starts to dominate is the decision maker's knowledge, behaviour patterns and personal preferences. Even though the land information system initiates the process through its monitoring function, it may only be referred to at this point and not accessed or reassessed in subsequent stages (the Bayesian and heuristic models of Appendix A5). Whether the information has been received, distorted or ignored by the decision maker will become apparent only by comparing the initial problem with the selected action. This will be a test of the decision making knowledge of the problem as much as, and usually more than, a test of the information provided by the land information system.

Such a use of the decision maker's experience and knowledge is more akin to the task of determining policy than to ordinary problem solving. As noted, one of the distinctions between policy making and problem solving is that ultimately policy is about what should be done, problem solving about *how* it should be done. Although what has to be done is obviously influenced by, and relies on, information about the problem and possible desired futures, the selection of a goal ends up being an ethical or value question. The decision-making and -taking models may be viewed, therefore, as an attempt to describe the relative significance of information on one hand and, on the other, the decision maker's knowledge and experience in problem identification and policy formulation.

It is the failure to recognise the progressive change in the use of information as we move from the inventory through to the decision-taking model that is the primary reason for attempting to assign into the problem and policy arenas the efficiency gains being achieved by land information systems at the routine/managerial levels. All that can be reasonably said, prescriptively, is that land information systems could beneficially be substituted for, or could incorporate, routine land related decision making procedures, and could provide direct, measurable benefits by facilitating decision processes at the management level. Beyond these two models, proof of benefit, or contribution, or even involvement, becomes much more tenuous.

Yet, it also seems reasonable to assert that any land information system which is to contribute to the policy process must contain most of the elements of the inventory or predictive models. The decision maker's experience and memory must be the determining factors since, in the final analysis, the selection of what has to be done, and how to do it, rests with the decision maker, not with some external information system.

Conclusions

This chapter, through constructing a series of models, has sought to throw some light on how land information systems and problem solving may be linked. The models illustrate, firstly, how the role of a land information system may vary from a position where it dominates and overrules the decision maker, to where the reverse situation applies and the decision maker's knowledge dominates the decision process, with little recourse to the capabilities of a land information system.

In each case, and perhaps paradoxically, when the decision maker plays the dominant role, the need for information is greatest. This follows, since, if an inventory model of a land information system is employed, the problem definition component becomes part of the process. This leads to an increased need for information for *understanding and learning* about the process to be followed as well as about the substance of the problem. When only decision making is involved, that is, evaluation and choice of alternatives, the problem solving process has been previously bounded, hence the amount and type of information required becomes confined to reaching a decision, not to defining the problem. It is therefore unlikely that land information systems designed primarily for efficiency at the administrative and management levels will contain either the breadth or kind of information that is needed to define the problem and shape the policy process.

It also follows that anything other than an *extended or modified inventory or predictive type of land information system* will probably be too prescriptive or rigid for use in the policy domain. Here, the extensions and modifications refer to the additional data, additional contextual and value domains, including their structure and function, that may need to be incorporated in such a system if it is to be effective in the policy process. These matters will be elaborated in Chapter 9.

The structure of present day land information systems is founded on the rational models of problem solving. Every facet of the rational choice model has met with criticism: problems are not always clearly defined; the arrangement of goals into a nested hierarchy is unrealistic; and it simply demands too much of the decision maker (Chapter 1). The logical stance that it is not possible to make a decision unless one understands everything about everything that might possibly affect a decision is simply unachievable in practice. In truth, though, all but the most rabid proponents would see such a goal as an ideal rather than a possibility [House & Schull 1988:148].

Those ideal conditions do apply for many of the uses described in Chapter 3; that is, the decision making model of linking land information systems and the decision making process. At the other extreme of the spectrum, where policy making is the overarching activity, these ideals cannot apply if it is to be "uniformly and *a priori* valuable to use information made available by land information systems in policy and decision making" (Chapter 1).

At best, a variance of the inventory and predictive type of relationship between the policy process and land information systems might prove to be of value. The structure of such a system, the data it will need to possess, the functions it will be required to fulfil, and its connection with the policy process and current land information systems for solving structured problems, will need to be derived. The next two chapters aim to define some of these parameters.

CHAPTER 6

PUBLIC GOALS AND POLICIES

> Land is the source of all material wealth. From it we get everything that we use or value, whether it be food, clothing, fuel, shelter, metal, or precious stones. We live on the land and from the land, and to the land our bodies or our ashes are committed when we die. The availability of land is the key to human existence, and its distribution and use are of vital importance.
>
> Rowton Simpson

Introduction

In the last two chapters, problem solving was viewed from a normative perspective, being treated as a sequenced means–end process of problem formulation – alternatives definition – choice. The use of both the means–end model and the normative treatment may be defended, not only on the grounds of explanatory ease, but also on the grounds that they do provide a reasonable model of problem solving under the control conditions that prevail within organisational structures. In these circumstances, decision making tends to be directed activities, focusing on relatively narrow issues, by persons who have the authority to define and who also manage the process without recourse to others save for the approval of the final decision. These conditions closely parallel those under which most land information systems operate today, be it in the private or public sector. These are also the situations under which we know land information systems to be of real benefit.

They are not the conditions, however, under which land management and related policies are formulated or promulgated. These processes operate in the public domain where neither the process nor its outcomes are subjected to anything like the same level of direction or control as in the private sphere. Given that the allocation and use of land is a process that creates distinct winners and losers – an exercise that creates wealth and, perhaps more importantly, distributes wealth – anything to do with the planning of land, our most fundamental resource, is destined to be a highly sensitive, emotive and political activity, of concern to a wide range of community interests. Moreover, these concerns are likely to extend well beyond the problem solving models of land information systems discussed in the previous chapters to encompass every facet of their formulation, implementation and operation. The distinction between problem solving, decision and action becomes blurred in the public arena to such an extent that the prescriptive models of the last two chapters are no longer acceptable representations of the actual processes involved. By the same reasoning, neither then is the presumed means–end link between land information systems and decision making processes.

This chapter will therefore need to define the place that land information systems have in the public policy process affecting land. To do this it will describe the context and processes by which public policies concerning land are formed, chosen and implemented, and how formal information is used and to what effect. To achieve these aims, firstly, the policy process in the public domain will be contrasted with the same activities in the private domain, to illustrate the differences in the two sectors and how these changes might influence the place of land information systems compared to their role in the private arena described in earlier chapters. Secondly, there are a number of characteristics of land which make it particularly difficult and sensitive to changes in policy direction. These are highlighted in a separate section. Lastly, a model of the public policy process is proposed and used to examine, from an information usage perspective, the activities included in the process and how policy decisions are ordinarily formulated and chosen. Some general observations on how land information systems do, and might more effectively, contribute to this public process concludes the chapter.

In this chapter, unlike the last, we are moving into an environment where, from the evidence in the literature, little is known factually about the benefits of land information systems [Smith & Wellar 1992] but where many believe, *a priori*, that land information systems should be of benefit. It is also an environment which of itself is elusive, continuous and essentially political, not technical by either tradition or inclination. The rules that applied to the application of land information system to well defined decision making process simply do not hold in any respect. It is suggested that the land information systems community will need to adopt an alternative perspective, a new view of its role in the land management policy process; a view that reflects the substantive issue with which one is dealing and the political circumstances that surround the debate over the issues, the process as well as their outcomes. This chapter is a first step in defining such an alternative view.

The Nature of Public Policies

To begin, it may be valuable to define a number of terms in the public policy field to indicate their meaning in the context of this and subsequent chapters.

DEFINITIONS

Public policy, reduced to its essence, is anything that government decides to do and how it will do it. It represents governments' view on the preferred state of affairs they wish to promote or secure for their constituents, be it social, economic, political, environmental. It also provides direction for programmes and plans (the means) designed to achieve the preferred social, economic outcomes (the ends).

Public policies tend to be elusive, wide ranging and liable to rapid change, for what is policy for today may not be in vogue for tomorrow. It is this state of endless flux, of alterations to means and ends at all levels (strategic, tactical and operational) that is characteristic of the way the public sector runs.

Problems cease to be private and become *public problems* when the consequences of fulfilling or not fulfilling a need, whether it be apparent or real, make demands on others not immediately affected. If, as a result, those others who are affected choose to act – i.e. convert the need to a problem – it becomes a public problem as the need to eliminate the problem can no longer be met privately. Hence a public is born – consisting of all those perceived to be affected and willing to act. As Jones quoting Dewey says, "the public consists of all those who are affected by the indirect consequences of transactions to such an extent that it is deemed necessary to have those consequences systematically cared for" [1977:16].

At any given time there may be a range of public problems confronting government. Of these, those demands that policy-makers either choose or feel compelled to act upon comprise the *policy agenda*. The policy agenda distinguishes the problems that are to be addressed from general political demands.

A problem normally does not achieve agenda status unless it becomes an issue: this happens when a public with a problem seeks government action and there is public disagreement on the solution. For instance, increasing levels of soil erosion nationally may be interpreted as a public problem; differences over what should be done, if anything, becomes an issue.

Issues are those problems that rise to the policy level simply because there are no easy solutions. If there were, the problem would have been solved within the existing policy framework and operational procedures. Furthermore, as they are not simple problems they are almost certainly not amenable to solutions based on scientific or rational decision making. For a similar reason, it is improbable that a particular public issue will originate from the scientific or technical spheres [House & Schull 1988:158] unless, as is to be discussed in Chapter 9, there is controversy amongst technical specialists about such items as method or data, and it has been allowed to spill over into the public domain.

Issues are usually, but not always, about conflicts between *objectives* held by different parties rather than between goals or aims. They typically arise when somewhere there is a threat to alter the status quo; that is, there is a potential shift in the existing power structure or in the present distribution of wealth. Hence, if water quality is placed on the public policy agenda by a water supply authority, conflict will almost certainly arise between a host of interest groups (individual farmers, farming groups, exporters, environmentalists) as to what should be done about it, but not so much about whether something should be done about it at all, since a solution to the problem of water quality is probably in the interest of all parties concerned.

DIFFERENCES BETWEEN PUBLIC AND PRIVATE SECTORS

Besides the ever changing nature of public policies noted above there a number of other significant differences between the "private" problem solving, decision making and policy procedures described in the last chapter and the public policy process. These are: the intervention of a public in the process; the involvement of interest groups; the plurality of objectives; and controversy over means, the justification of problem selection, the vagaries of the political environment and the complexity of contemporary problems.

Public Intervention

The first of these is that a public intervenes between a problem and its solution. Unlike the "public" in an organisation or a group, the behaviour of members of a democratic society as a whole is not tightly controlled and, if anything, is permitted to be non-compliant. The formulation and implementation of much public policy, however, is dependent on "action by groups that are relatively autonomous and not subject to the direct authority of those making policy" [Barrett & Hill 1984: 226]. The task of solving a public problem is then one of inducing social change by persuading many self-regulating people to behave differently than they may have in the past or may want to in the future. By contrast, the resolution of a technological problem or the selection of policy in the private sector normally requires compliance by far fewer individuals whose behaviour may be closely directed. It becomes much simpler to employ formal analytical tools, such as land information systems, when the number of participants and their behaviour may be anticipated (modelled).

Interest Groups

Yet, by and large, for the vast majority of issues, everyone who has something to say will wish, and politically may need, to be heard. Normally, therefore, it becomes very difficult predicting in advance the number and intensity of participation by special interest groups.

Furthermore, as House and Schull [1988:165] note, even if a particular group does not have an active or formal interested constituency, it may nevertheless be affected. If they perceive the impacts to be serious enough, they may be brought into the issue resolution process by one of the other adversaries. House and Schull therefore argue that this mode of issue resolution, unlike the rational and comprehensive, i.e. analytical, ones advanced by many in the land information community, already address the need to be alert to as many potential effects of policies as possible. A similar point of view is expressed by Ingram and Mann[1983:700] with regard to the formulation of environmental policies.

This "social" resolution process – the "norm" for solving public problems – could be viewed as an alternative to formal analysis to derive acceptable and "correct" policy options in the social and political domains. There is evidence, however, to suggest that this process may be of limited utility outside the socio-economic arena – for example, when dealing with substantively technical or scientific issues [e.g. CEPA 1992]. A task for this study, then, is to determine when, and how, formal algorithmic-based analysis processes play a role in such a policy process. This point will be taken further in Chapter 10.

Plurality of Interpretations and Objectives

As a consequence of the large number of people (actors) involved in the public policy process, when something does happen in society it will more than likely be subjected to a wide range of interpretations by individual members of the public who, if they perceive it as a problem, are likely to propose an equally wide range of remedies or actions. A public policy issue may therefore be described as

> a fundamental enduring conflict among or between objectives, goals, customs, plans, activities or stakeholders, which is not likely to be resolved completely in favour of any polar position in that conflict
> [Coates 1978, quoted by House 1982:10]

Since everything tends to be related to everything else – for example, energy to economics to the environment to transport to health – and each has its own constituency and agenda, congruity in identifying needs, let alone policies to remedy these needs, cannot be expected. Accordingly, the number of policy proposals emanating from a single event may be numerous, may vary greatly in intensity, scope and complexity, and may be disparate and hence generate controversy.

Means Controversy

In the public domain, unlike in private problem solving in the main, this controversy usually surrounds the means rather then the ends to be obtained. While in both sectors overall goals or aims may generally be non-controversial, in the public sphere consensus on policy objectives and policy implementation is generally not possible, due to the inter-group conflicts as to what constitutes an acceptable means. Mostly, for example, people agree with the aim of eliminating industrial pollution or the preservation of wilderness but there would be little agreement on who should pay for it or what concomitant economic or social sacrifices would be acceptable. Thus there is likely to be a plurality of objectives and policies for any event which makes it difficult, if not impossible, to pursue a unique goal, rendering policy making and policy "a dominant dimension of societal problem-handling capabilities and of the capacity to govern" [Dror 1983:4]. In the organisational/managerial sense of the terms, the tendency therefore is for controversy to surround the means, and to a lesser extent, the ends. Since, as noted in preceding chapters, the strength of land information systems lies in solving rule based problems, their contribution to the public policy process will probably be quite varied in administrative and operational tasks to which they are normally applied.

Justifying the Choice of Problem

The crucial problem in the policy process, then, is the management of conflict about, firstly, which issues should be attended to, that is, be placed on the political agenda; and secondly, the way selected issues should be addressed, i.e. how the problem (issue) is formulated and implemented. In each instance, the choice is likely to be determined through such tools as political persuasion, or argument based on economic or social equity to maintain a balance between the warring interest groups at all stages of the issue resolution process. These are not the methods of land information systems, and that makes it difficult to foresee how they can contribute anything other than indirectly to this process.

Justifying the selection of one problem formulation over another becomes, as Dror [1983:8] notes, a question of selecting one perception of reality over another. In other words, the policy process needs to distinguish between the competing realities represented by a variety of publics, by choosing "a" problem formulation. Yet to suggest that there is "a" problem having "a" solution is normally misleading, particularly when the issue concerns highly contentious matters such as land use. The idea of problem formulation in a means–end, problem solving–choice of solution sense, with disputation solely about which possible solution represents an appropriate response, may be sustained only as long as the goal to be achieved (the problem) is not defined in operational terms. For as soon as this is attempted, more than one problem and more than one solution are likely to be identified and formulated – none of them correct or incorrect. A choice has to be made as to how we wish to formulate *a* problem [Lindblom & Cohen 1979:53] – which reality or aspect of reality, from many, we choose for action.

In practice, to avoid what could otherwise become an endless process in both time and extent, the policy maker has to at least temporarily fix or "goal close" the grand world (of all conceivable futures) into that "small world" which temporarily constitutes the requisite problem representation [Berkeley & Humphreys 1982: 219]. This then constitutes the formulated problem for which solutions have to be formulated and chosen.

Yet ultimately, as Dery writes, "what requires justification is the choice to tend to one rather than to the other, not whether a certain formulation captures 'the' problem or root causes" [1984:62]. This is a question of assigning values and allocating benefits and privileges in the community, not a question of logic, or quantities, or absolute right and wrong. It is an allocation process largely controlled by the prevailing values and beliefs, where the immediate political culture determines the particular policy alternative selected. Even then the various interests may act to maim or destroy the chosen policy option during the implementation stage of the policy process.

Public policy formulation and implementation is, therefore, a continuous, dynamic process where the correctness or otherwise of a particular policy formulation may be of only ephemeral interest to the opponents of the decision. It relies on all types of information – facts, belief, rumours, falsehoods. Where appropriate, a land information system could be a contributing information source like any other, but it is unlikely that, at least in the minds of the policy maker, there will be anything special about it or that its information will carry more weight than other sources simply because it may have been scientifically analysed or verified.

<u>Fluctuating Political Environment</u>

Another difference between private sector and public sector problem solving is the necessity of having to describe a continually varying *political context*. It requires detailed and wide ranging investigations to identify the participants in, and audience for, the candidate problems and issues, covering such diverse groups as state and national government institutions, private sector interests, public interest groups, and individuals. As time constraints seldom allow the canvassing all such groups for input, information sources must be selected from those areas that are likely to contribute most in the view of the decision maker. Hence information gathering will normally be: selective rather then comprehensive; confined to readily accessible and known sources; through a limited search confined to information that is in a format and style that is immediately useful

[Quadrel & Rich 1989]. The impact that these information-searching and utilisation characteristics have on the utility of land information systems in the public policy process will be detailed in the next chapter.

Complexity of Modern Problems

Lastly, in keeping with the discussion in Chapter 3, modern decisions are prone to be very complex. The infiltration of high technology, especially rapid communication and transportation, into most aspects of contemporary life means that decisions are more widely discussed, their implementation expected more quickly, and evidence of success or failure widely sought and known. At the same time, in a growing number of cases, scientific and technical uncertainties (to be discussed in Chapter 9) may be present and may become complicated by the existence of multiple stakeholders holding conflicting interests and images about the given technical problem. Taking this together with the fact that common sense is no longer always a reliable guide to the impact on, or society's experience with technological phenomena [Winner 1977:19], makes it hard to conceive a candidate policy that will not affect many other areas of interest (economics, education, environment, energy and so on) or will not generate controversy. "Under such conditions, decision making must necessarily become less an analytical endeavour than a process of mediating among parties with differing levels and types of knowledge" [Hart 1986].

Yet, precisely because of such uncertainty and conflict there is also an ever-increasing demand for information to cope with it and to suggest directions for future plans and strategies [Western & Wilson 1977:xiii]. But, as many public policy issues concerning the impact of science and technology on society in general, and on the health and well-being of our land specifically, have heavy emotional "crises" or political "overtones", it is hard to address such issues in a rational manner, because an unbiased quantification of these psychological factors is not possible [House & Schull 1988:158]. Accounting for these factors, in one form or another, in a (land) information system appears to be an equally daunting task.

SUMMARY

There are substantial differences between the way policy is formulated, selected and implemented in the private and public sectors. The process in the public sector is such that the simple normative assumptions contained in the problem solving models of the previous chapter can in no way be deemed as descriptive or representative of the actual process. With this background it is perhaps easy to see why decision models developed principally by scientific related disciplines have been generally ill-suited to the task of resolving public sector issues, especially for land-related issues. The next section will illustrate this.

The Nature of Land Management Policy

Land management policy and planning, in common with other land-based policy issues like those dealing with the environment, have all the characteristics of the public policy described above. They are also different in several respects. The first of these is their scope; the second, the way land-use planning issues are addressed.

SCOPE OF LAND MANAGEMENT ISSUES

Land is our most fundamental resource, to which all our endeavours and activities are either directly or indirectly connected. While to some this perspective may exaggerate the scope of land management concerns, it nevertheless suggests the extensive and pervasive character of land management and related policy areas. How land is used can have a direct bearing on aspects of human health and safety, food and energy production, wilderness and recreation, the survival of biological species, and the supply of scarce resources whether renewable or non-renewable. Almost everything and every one ends up being affected in one way or another.

If the balance between these components is changed, or is proposed to be changed, then there is likely to be a wide, complex range of interrelated and divergent opinions as to what actions government should take. As Harrison [1977:16] observes: “It is now common ground that land-use planning, with its associated policies, is an inherently political activity” since land-use planning is essentially the activity of allocating resources as a whole, not merely land itself.

Further, the question of how land is managed and used and whether this is acceptable depends on what people – individuals, groups and interests – want it to be. Unsuitable land use, for example, are all those uses which interfere with its use for some socially desired purpose. If we want to use a particular portion of land for recreation when its current use is residential, or if we wish to use a body of water for domestic consumption when it is being used for industrial waste discharge, then its present use is inappropriate.

Land use, then, cannot be defined with any scientific or mathematical finality, since its definition hinges on the concept of human use. Use has to be placed in a context. As will be argued in Chapter 9, so too does the information emanating from land information systems if they are to be of consequence in the land management policy process.

There is an expectation that we may be able to define scientifically the properties necessary for a particular land use. It is this approach that dominates the land information literature. However, the definition of what constitutes suitability depends on the public's decision as to what it wants to make of its land [recent examples are in Geertman 1990, French & Belknop 1991, Cook & Potter 1992]. Hence, from a public policy perspective, land-use planning, just like its cohort the environment, is a political or policy problem, representing the community's collective interests in the land.

Secondly, people's involvement in land policy issues in Western societies has been, and is likely to continue to be, extensive and pointed, reflecting the widespread ownership of land, its actual or perceived value, and the expectation of profits from increases in these values, coupled to a highly structured process of public decision making to determine such things as permitted uses. Also, where land-use planning occurs, it is mostly a local government policy matter, with very specific local applications, with the result that those most directly affected are generally aware of what is being decided and are able to organise for or against a proposed action.

Thirdly, land, for all practical purposes, is a finite resource. With increasing population densities, strong competition for land is being created among public and private, individual and corporate users of space, especially if Raup's [1980] view of land "gradually acquiring the characteristics of a consumption good" is accurate. In a strong laissez faire, free-market land environment, this scarcity has given the entrepreneur unusual opportunities and incentives in the search for profits.

LAND-USE PLANNING ISSUES

By and large, the main government policy mechanisms to maintain a socially and politically acceptable balance between the "fee simple" rights of individual land ownership and society's collective needs have been various forms of land-use zoning and controls on land subdivision. In the main, loopholes and variances in planning and subdivision ordinances have favoured growth and development, allowing private interests to achieve the land use changes and profits they seek [Wengert 1983:653]. Biases of this type, together with general environmental concerns, have led to public disquiet about the supply of, and demand for, land for such uses as agriculture (e.g. preservation of prime soils for food production [Byrne & Strachan 1992]) and recreation (availability of land, desire for open space [e.g. Niemann 1987]), as well as concerns about ownership (corporate, foreign, absentee ownership [Appendix C3]) and the need to manage urban growth and regional disparities.

These types of land management issues result in trends towards greater pressure for intervention by the state in the land management process [McLaughlin 1981]. The freedom to use one's private land, and also the public lands, is of interest to almost everyone, and it is linked with strong vested interests in retaining profits from what is becoming a scarce resource. These factors ensure that any public action aimed at directing land management practices towards some more desirable social, political or economic balance is likely to be contentious, and will attract significant numbers of highly polarised interest groups with a multiplicity of aims and agendas. As Annells [1987] observes, land management and land use issues are, and will continue to be a highly politically sensitive area where a highly developed understanding of the political art of the pssible is required.

Given that the issue of land use is in most instances inseparable from, and intertwined with, environmental concerns, substantial change in policy through the normal public policy processes may have little appeal, and may lead to demands that are less negotiable than in other, less volatile policy areas [Ingram & Mann 1983:687]. There are likely to be many interest groups, more winners and losers, a severe absence of consensus on objectives and more favoured methods for solving problems than for most other public policy issues.

> There are many parties whose interests in issues have different focuses. Some parties are in conflict because they disagree about the facts and/or consequences of a course of action; others because they will be negatively affected by the proposed action in terms of reduced uses and/or increased costs; and others, while not directly affected, because they perceive the action to be contrary to the common good of the community and that they should therefore have a moral obligation to be involved.
>
> [Smith 1990]

Consequently, the application of formal methods, such as land information systems, to land management decisions does not in itself reduce conflict, but may generate additional controversy at all stages of the public policy process. It is also to be expected that these methods will be subjected to detailed questioning and substantiation, including challenges to the models, analytical methods and data on which they rest. There is some evidence that questioning of the propriety of land information systems for such value laden applications is beginning to occur [e.g Ingles & Woods 1987, Healy & Asher 1990].

The contribution that land information systems could make in such a policy setting environment is, therefore, likely to be even more indirect than many in the land information system fraternity suspect. This point will be explored further in the chapters to follow.

A Public Policy Model

The above discussion on public policy in general, and land management policy in particular, provides a general background to the context in which the public policy process operates and to which land information systems will have to adapt if they are to be of relevance at all in this process. Of particular interest for this study, and where the rest of this chapter will directed, is how, in this value laden, ephemeral and fluid environment where politicians are often more interested in "public emotion than hard fact" [Kindleberger & Topping 1992], a decision to proceed with this or that land management issue or planning action is made. When a suitable description of this process is available it may then be possible to begin to examine the part that inventories of structured data, with extensive analytical and presentation capabilities, could have in selecting and implementing the chosen policy alternative.

To describe the public policy process and the role of information in this process, use will be made of two models. The first, a conceptual model of policy change and policy-oriented learning proposed by Sabatier [1987, 1988], will be used to view the place of land information systems in the policy process relative to the other inputs affecting the land management policy sub-system. To describe the role of information in the process of "deciding" a preferred policy position, the model of unstructured strategic decision making proposed by Mintzberg et al. [1976] will be employed.

A MODEL OF THE PUBLIC POLICY PROCESS

During the procedural planning period rational policy based models closely resembling the decision making models of Chapter 5 were in vogue. As noted in Chapter 3, the explanatory and process shortcomings of these models led to calls for policy process descriptions that would emphasise process rather than outcomes and would stress policy learning based on implementation evaluation and for iterative bottom-up approaches using advocacy coalitions as a mechanism for reaching policy outcomes. This has led to a number of diverse and at times competing policy models that have all nonetheless

> clearly and unambiguously moved away from variants of a narrow model of rationality decision-making towards a broader model of reasoning that recognised the epistemological basis of many "rationalities" that give meaning to actions in particular contexts of time and place.
>
> [Cahill & Overman 1990]

Amongst these models is one proposed by Sabatier [1987], which is of particularly interest for this thesis as it "seeks to integrate the heretofore largely separate literatures on (1) knowledge utilisation, and (2) policy change". Sabatier argues that the political scientists and their literature have been slow to examine the role of substantive policy information in the practice, and in the theories, of public policy making, apart from the support it gives to the view of policy as a product of power struggle amongst groups.

The Model

Sabatier's model emphasises the function that policy analysis has in policy oriented learning, and the role that such learning plays in its turn in policy change over time, i.e. for periods of a decade or more. It is an amalgam of theoretical arguments and empirical findings which acknowledge that:

1. Policy analysis is often used in an advocacy fashion to justify positions of interest.

2. Institutional arrangements, political resources, organisational interests – i.e. non-cognitive factors – play a major part in policy change.

3. Policy effects are usually seen via long-term, diffuse effects on policy makers' perceptions of causal relationships and states of the world (i.e. their belief systems).

The model therefore draws on Toulmin's [1958] models of argumentation, Lindblom's [1959] incrementalism, Mitroff et al.'s [1982] adversarial policy-making model and Heclo's [1974] notion of policy-oriented learning.

As illustrated on the left side of Figure 6.1 there are two sets of variables in this model; one set fairly stable, the other more dynamic. Each acts as constraints and opportunities for the policy sub-system actors depicted on the right side of the figure. According to Sabatier, these "policy sub-systems", integrating public and private actors with shared interests in a particular arena, provide a better means of understanding policy than solely viewing policy in terms of government action.

Two features of this policy-oriented learning model of the policy process are of some significance for studying the role of land information systems in the policy process land management issues. These features are the separation of stable and dynamic policy variables, and the process of policy learning.

Stable Policy Variables

Depending on what is considered to be land management information, most of the information held in a land information system for land management policy purposes will fall into the relatively stable category of Sabatier's model. Information on the physical properties of the land, its location and resources, data on its current use, and basic social/demographic characteristics, for example, tend to be either immutable or non-volatile. What will change, however, through such things as alterations in socio-economic conditions, or in governing coalition, is the use made of this information by the policy actors; that is,

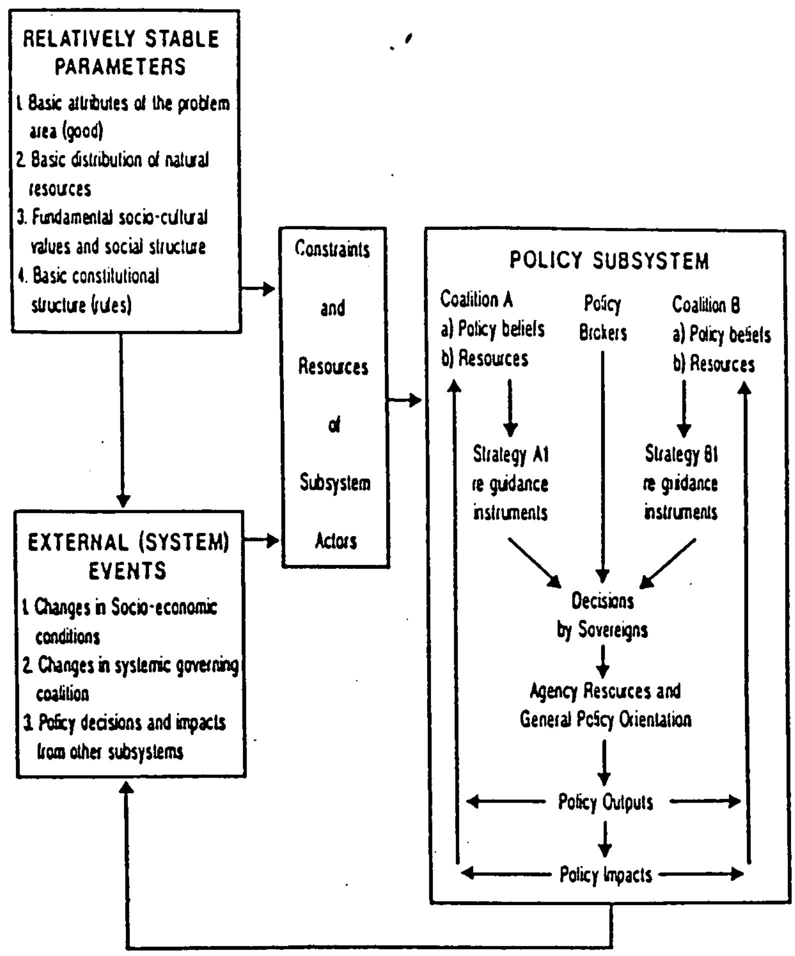


Figure 6.1 A Policy-Oriented Learning Model [Sabatier 1987]

how it is used to justify a position, the context in which this occurs, and the values that are assigned to it.

It is these dynamic influences from either external events or from belief systems which provide some of the principal sources of policy change and determine the utilisation, significance and impact that this information has in the policy process – probably as much, if not more, than the nature or extent of the information itself. As will be argued in the next two chapters, unless the land information systems community can escape their traditional, rational context and modify their systems and the information they supply to accommodate dynamic factors and views, then they are unlikely to make a meaningful contribution in the policy process.

Policy Learning

Within each policy sub-system, it is assumed that actors will combine into a number of advocacy coalitions composed of people from various organisations who share a set of normative and causal beliefs and who often act in concert. For land management issues these may typically consist of conservation groups, rural organisations and land development interests. At any particular point in time, each coalition adopts a strategy encompassing one or more policy directions that it feels will further its objectives. Should these directions be adopted, Sabatier's process includes structures which incorporate the coalition in the policy process. Consequently, over time, a stable policy sub-system, with shared core belief systems about the nature of the policy issue, will emerge to support policy learning and incremental development of that sub-system.

Strategies from various coalitions which conflict with each other are normally mediated by a third group of actors, termed "policy brokers" (Figure 6.1), whose main task is to find some reasonable compromise that will reduce the intense conflict. Compromise, however, usually only affects secondary or subsidiary values, not the core values of the sub-group. The end result is one or more governmental action programmes that in turn produce policy outputs at the operational level. Then, on the basis of the perceived adequacy and impacts of these government decisions, as well as changes to the external dynamics and the knowledge base, each advocacy group may revise its beliefs and modify its strategy.

The key element of this view of the policy process is to achieve policy-oriented learning through receiving post-implementation information on the extent of any policy performance gaps and the reasons for them. While such "'learning from experience" is difficult in a world where causal theories are often lacking and opponents are normally doing everything possible to muddy the issue, "without such knowledge, accurate learning from experience is difficult" [Sabatier 1987].

Prima facie, land information systems, modified as much as this is possible for policy purposes, potentially offer a means by which to compare some of the policy achievements with planned policy outcomes and actions. Monitoring and analysing change in land use or ownership at the operational and planning levels represents a significant present-day application of land information systems; e.g. Rump and Hillary [1987], Geertman [1990], French and Belkap [1991]. Alterations to the land information system contextual, value and learning capacities as recommended in Chapter 9 (the policy-oriented land information systems) may also enable these systems to provide wider ranging information and explanations on the causes for policy shortfalls, thereby assisting a better understanding of policy impacts to gradually emerge over time. For as Sabatier observes,

> despite the partisan nature of most analytical debates and the cognitive limits on rationality – actors' desires to realise core values in a world of limited resources provide strong incentives to learn more about the magnitude of salient problems, factors affecting them, and the consequences of policy alternatives.

It therefore seems likely that if policy processes of this type were to be used for ameliorating land management concerns, the role of policy-modified land information systems in the policy process would be more direct and measurable than is presently possible.

A MODEL OF THE PUBLIC POLICY DECISION MAKING PROCESS

To look at the "policy decision" process within and between Sabatier's policy sub-groups, we will use a model of unstructured strategic decision making proposed by Mintzberg et al. [1976]. This model is the result of an empirical study, extending over some five years, of the strategic decision making processes of twenty-five organisations, in both the public and private sectors. It will be shown that for the purpose of describing the place of formally structured and presented information, the model is also an adequate description of the public policy process.

The authors define unstructured decision processes as those that have not been encountered in quite the same form(the norm in public policy making); "for which no pre-determined and explicit set of ordered responses exists in the organisation". Strategic is simply defined as meaning "important, in terms of the actions taken, the resources committed, or the precedents set" [p. 246] – factors that also apply to public policy formulation.

Mintzberg et al. analysed their observations to derive a basic framework, consisting of some twelve elements (depicted in Figure 6.2) that describe unstructured strategic decision processes. The framework consists of: the

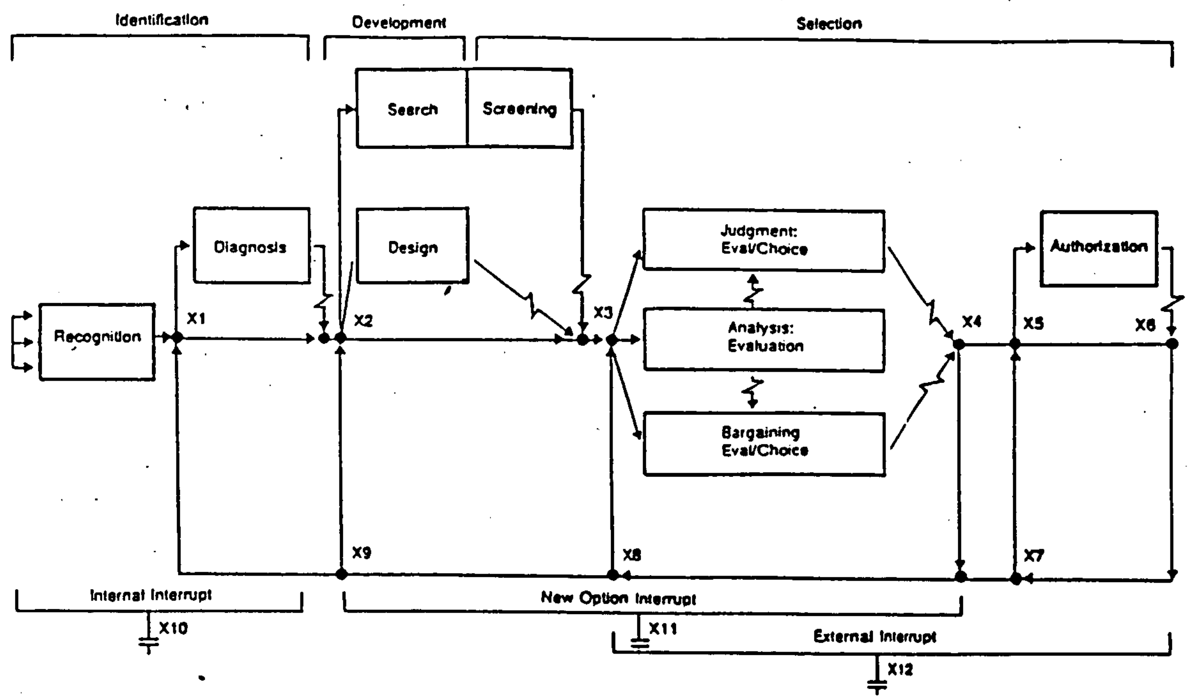


Figure 6.2 A General Model of the Strategic Decision Process
[Mintzberg et al. 1976]

three *central phases* including (1) identification (consisting of recognition and diagnosis programmes), (2) development (consisting of search and design programmes), and (3) selection (comprising screening, evaluation/choice, and authorisation programmes). There are also three sets of *parallel processes* including, (4) decision control processes, (5) communication processes, and (6) political processes. Also, there are the *dynamic factors* which are the key distinguishing features of decision processes that are strategic. They include (7) interrupts, (8) scheduling delays, (9) feedback delays, (10) timing delays and speed-ups, (11) comprehension cycles, and (12) failure recycles. A description of the operation of the model is given in Appendix B.

As Mintzberg et al. note, there is a fairly extensive normative literature on strategic decision making, but these techniques have a low "descriptive reality value" because the kind of unstructured, strategic decision making processes they describe are "not the decision making under *uncertainty* of the textbook, where alternatives are given even if the consequences are not, but decision making under *ambiguity*, where almost nothing is given or easily determined" [p. 251, emphasis in original]: i.e. neither goals, objectives nor policies are in place. Strategic decisions, they suggest, are characterised by novelty, complexity and open-endedness, with little understanding of the decision situation to be faced and with only a vague idea of the decision process or the solution to be attained. Thus "only by groping through a recursive, discontinuous process involving many difficult steps and a host of dynamic factors over a considerable period of time is a final choice made" [pp. 250–251]. Again, this is indicative of the public policy process.

JUSTIFYING THE MODEL

The Mintzberg et al. model is an organisational perspective of strategic decision making drawn from surveys of private and public sector organisations. Given this organisational based and biased model, is it reasonable to use it also as *a model* for representing the public policy formulation process, to adequately describe the possible involvement of land information systems in this process? Alternatively, is the model sufficiently representative, prescriptive or even descriptive of the public policy formulation process in general, to enable it to be used to evaluate the policy decision (selection) process and hence the characteristics of information usage we need to determine in order to assess possible roles for land information systems in the public policy process?

Two points of view on these questions are briefly discussed below.

Organisational Perspective

To Jenkins, for example, the answer to the first question is in the affirmative, for he argues that an organisational perspective on policy making provides a sounder basis on which to analyse policy than competing perspectives such as those offered by policy output studies or contingency theory [1978:46–82]. While recognising the prescriptive limitations and paradoxes of an organisational perspective, he proposes that it has potential as it concentrates "on dominant groups, on conflict, on ideologies, on the acquisition of power and on change in varying structures and varying environments" which is suggestive of policy initiation and political behaviour [p. 81].

A similar focus on the interaction between power–interest structures, participating actors and agencies is used by Barrett and Hill [1984]. Their approach, like that of Mintzberg et al. [1979], moves away from formal organisational hierarchies, communication and control mechanisms and emphasises the multiplicity of actors and agencies involved in policy; their linkages, value systems, relative autonomies, and power bases; and the interaction that takes place between them particularly during negotiating and bargaining [pp. 220–222]. Like Jenkins, while they are critical of certain aspects of organisation theory, they believe an organisational view provides a useful approach for the analysis of biases and power in policy formulation and implementation [p. 238].

System Analysis Perspective

An organisational perspective of policy making is, however, only one surrogate view; a closely related, analogous theory to describe the policy process. An equally valid starting point – and one that is close to the land information systems' communities scientific tradition – is one that originates from the systems analysis field (or to be more precise the shortcomings of these methods) typified by the works of such authors as Lindblom [1959], Dror [1967] and Quade [1982], where policy analysts attempt to describe and construct models of public policy making and analysis. For the sake of brevity just one of these, Lindblom's "disjointed incrementalism" will be summarised and compared with the Mintzberg et al. model.

The strategy of "disjointed incrementalism" proposed by Lindblom [1959] and expanded in Braybrooke and Lindblom [1963] describes a set of practices or adaptations, among many, representing "a point of convergence for policy analysts in their adaptations to the difficulties of problem solving and evaluation" [Braybrook & Lindblom 1963:82]. The keystone of the incrementalist model is that evaluation and decision making are inseparably linked and are "focussed on incremental alterations of existing social states" [p. 84] which accords with Mintzberg et al.'s findings that "search begins in local or immediately accessible areas, with familiar sources" [p. 255] and that few organisations opted for "custom made solutions", relying instead on existing or modified solutions. Adopting or modifying an existing solution is akin to an incrementalist approach to decision making wherein the amount of uncertainty introduced into a solution process is minimised. A custom made solution, as it is untried, *ipso facto* introduces more uncertainty than the incrementalist approach.

Similarly, both models contend that search, evaluation and analysis are stepwise, serial procedures but, as noted in Mintzberg et al.'s model, only for a limited number of possible solutions, and for much the same reason as Braybrook and Lindblom: i.e. "if the analyst limits his attention to policies that differ only incrementally from the *status quo*, then it follows that he attends to a smaller variety than all the possible policies that might be imagined" [p. 88]. There are few discrepancies between this and Mintzberg et al.'s model; which is not altogether surprising, as both models are essentially descriptive rather than prescriptive, closely aligned to the Bayesian and heuristic decision making models of Chapter 4.

<u>Summary</u>

As House and Schull [1988:141–147] observe, most efforts to construct models to support or supplant the public policy process implicitly suggest that the modellers understand the variety of ways in which policy decisions are actually made. The model designer endeavours to clarify and make the policy process understandable to both those inside and those outside the policy process. The Mintzberg et al. model attempts to achieve a similar level of understanding of the unstructured decision making process at the strategic level. As the comparison with the organisational and system science based policy models indicate, the characteristics of the Mintzberg et al. model also parallel the description of the public policy decision making process portrayed in those models.

Mintzberg et al.'s model can therefore serve, as much as any model can, as a basis for gaining an understanding of the policy decision process and the part that various types and sources of information play in selecting the preferred policy option(s).

The Policy Decision Process

According to Mintzberg et al., the steps in the decision process do not form a steady progression from one routine to the next, but rather comprise a dynamic, open-ended system subject to interferences, feedback loops, dead-ends and so on. Of these, timing delays and speed-ups appear to be the major (tactical) factor in the decision process. These dynamic factors, they observe, are perhaps "the most characteristic and distinguishing features of decision processes that are strategic" [p. 263] or political in nature.

The model is, therefore, quite different from the prescriptions of problem solving and decision making offered in the preceding chapter, as Table 1.2 indicates. Yet, despite these differences and the uncertainty surrounding the goal (and how to evaluate it), the model exhibits Bayesian tendencies within the confines of a single problem definition. This is due to the decision process being largely recursive within a goal choice but not amongst goals. Small, goal-closed worlds are established to temporarily fix what in effect could otherwise be an endless confusion of goal setting and decision processing [Berkeley & Humphrey 1982:219]; the same problem as a land information system has a Decision Taking system in the last chapter.

The rejection of a problem definition tends to be infrequent as Mintzberg et al. report only four cycles out of the ninety-five returning to the identification stage [p. 265]. This occurs even when a decision process is blocked or fails, the return being to the development phase rather than the identification phase [p. 266]. For the decision maker, therefore, the problem has been defined and in that respect parallels the normative models of the previous chapter.

As is to be expected from the operation of Mintzberg et al.'s model and the essential political nature of the policy selection process – whether the organisational politics of Mintzberg et al. or the public politics surrounding land management in our case – the policy evaluation–choice process is quite different.

Three modes of policy evaluation, judgement, bargaining and analysis, are considered in the model. As opposed to the normative literature which emphasises the analytic mode of evaluation and choice, the study found "very little use of such an analytic approach" [p. 258] and identified judgement as the dominant, favoured mode. Commenting elsewhere, Mintzberg himself notes that "Analytical procedures cannot be brought to bear on work processes that are not well understood" [1973: 133].

Bargaining appeared in more than half the decision processes. It is also the vehicle through which political influence is exerted on the decision process, particularly to exercise control over the choices [p. 262].

As the authors note, considering the importance of the decision processes studied, the small use of the analytical mode is perhaps surprising. In only eighteen out of eighty-three instances could evaluation be separated from choice, leading to the suggestion that "evaluation and choice are intrinsically intertwined" [p. 258]. This, together with the fact "that the selection of strategic alternatives requires consideration of a great number of factors, most of them 'soft', or non-quantitative", leads the study to conclude that "the evaluation–choice is in practice a crude one" [p. 259]. Crude in the sense that it is not rational; that there may be no reasoned causal link between the decision and the available knowledge.

Hence, the implicit assumption by the land information systems community of a problem definition–decision making (i.e. evaluation–choice means–end hierarchy) at the public policy level is incorrect. A plethora of value and factual issues, many involving emotions, politics, power, and personality, enter the process, each requiring attention and consideration. If these are the conditions that apply, then the analytical/modelling capabilities that are assumed to underlie the use of land information systems in the policy process are, in anything but the most indirect manner, also invalid. At the very least, these rational based assumptions need to be redefined.

To do this, it will be necessary to gain an understanding of the public policy process and from this, the part that information, and especially formally structured land information, plays. Once this part is known, it may be possible to begin enhancing the inventory and perhaps the predictive models of land information systems as a decision processor of the last chapter, to better determine the structure and role that land information systems take in the public policy process.

To commence this redefinition process three closely related modes of evaluation–choice used in the public policy process, namely analysis, bargaining and judgement, are discussed next.

USE OF ANALYSIS

The selection and evaluation characteristics noted by Mintzberg et al., plus the low incidence of analysis, are representative of most descriptions of the public policy process [e.g. Jones 1977, Anderson 1984, House & Schull 1988]. They indicate that in the normal mode of making a public policy decision, some official person or body approves, modifies, or rejects a preferred policy alternative, selected from a range of pertinent and acceptable proposed courses of action compiled through an evaluation–choice procedure by career officials and government advisers. This will be based on agendas and problem definitions either proposed by them or closely defined from the top. But, unlike rational decision processes, what is typically considered at the policy decision stage is not a selection from among a number of full blown policy alternatives – i.e. fully analysed, evaluated or comprehended alternatives – but, rather, action on what may be called a preferred policy alternative – one for which the proponents of action think they can win approval, even though it does not provide all that they might like [Anderson 1984:53].

The emphasis is to ensure that the proponent of a view wins a particular point politically, irrespective at times of the rights or wrongs of the view held. In many instances, the focus of the issues or their solutions may therefore be, on making the case, deliberately restrictive to one perspective or one set of information. Furthermore, only the most favourable interpretations of one of these narrow issues or proposed actions will be presented and promoted. In Davis and Greenhalgh's [1980] words, "social choice processes consider only those values which process participants see fit to explicate." Hence, winning is seldom enhanced by attempting to analyse the policy exhaustively against all the possible alternatives or the real impacts it might have.

Analysis and politics do not always sit easily together. Analysts tend to assume that explicitness and clarity of reasoning are virtues always to be pursued. Politicians may find it pays to obscure issues in the interest of getting things done and stilling opposition. It is perhaps not surprising, then, that according to House and Schull

> The amount of influence on the political decision of the analytical work is not a function of its quality, veracity, or sophistication, but rather a function of the political nature of the issue and the politician's skill and will to use the analytical information.
>
> [1988:178].

Similarly, as Healy and Ascher [1990] argue, the confidence of many in the natural resource policy area that increased validity and certainty of information, through verification and analysis, will reduce conflicts and lead to concensus, is naive. They suggest in fact that the opposite may happen; that there is a strong possibility the availability of the information will change the intensity of demands the relevant actors will make, as well as altering their demands for how policies affecting natural resources are to be made. As a result there could be changes in: the overall balance of support for competing objectives; the degree of polarisation between competing preferences; and how these policies are made through such factors as gains or losses in legitimacy, and the relative power of political and bureaucratic institutions.

Of itself, therefore, the information may not prove to be persuasive in determining a particular policy outcome, even though highly significant in shaping the process. The next chapter will examine this proposition in more detail.

Policy analysis whether it is accepted or largely ignored in the policy decision, is quite different to what is understood by analysis in land information systems. While policy analysis is "the systematic investigation of alternative policy options and the assembly and integration of the evidence for and against each option" [Ukeles, quoted in House & Schull 1988:3], the types of factor considered and the decision criteria used in making a choice are radically different to the rational based choice processes normally employed by land information systems. Policy analysis has to be concerned with the source of the issue, the criteria for setting the policy, alternative decisions that might be made, the impact of these decisions, and the institutions and groups that may be affected. For example, as the Department of Conservation, Forestry and Lands in Victoria found when formulating their forest management policies, they had to acknowledge and attempt to take account of: groups who were strident critics of any concept of forest harvesting; different perceptions of risk factors in forest management actions; and major ideological and value differences in terms of relative worth of social, economic and environmental aspects of forest management [Smith 1990].

In other words, policy analysis provides and uses information about how various values and interests, which are almost always in conflict, are being or could be accommodated in a policy making process. After all, the power base of the political level comes from this source [House & Schull 1988:212]. Policy makers will also use technical information if it helps to win a preferred position, or if it is a technical issue, but these are rare at the policy level. It is therefore not unexpected that Mintzberg et al. note that "there is considerable evidence that political activities are a key element in strategic decision making" [p. 262]. It is also perhaps not unexpected that those calling for a greater use of land information systems in policy making have apparently so far failed in their attempts to convince policy makers of the benefits that will accrue to them (or to their constituents) by the use of their system in the policy process. This is not to say that land information systems, like policy analysis, do not have a place, or do not make a contribution to the policy decision process. It is just that this contribution is probably less direct than is envisaged by most.

USE OF BARGAINING

After noting the political influence in the decision process, Mintzberg et al. suggest that this influence manifests itself "in the use of the *bargaining* routine among those who have some control over choices" [p. 262, emphasis in the original]. In land-use policy and planning this "control" would equate to interest groups, planning officials, and politicians at the state and local levels. They go on to observe that it is principally the bargaining process which causes delays and additional cycles in the decision process, and they suggest that bargaining is most prevalent when the decision is important, or contentious to one or more of the interest groups, and when control over choice rests outside the organisation, that is, in our case, with the interest groups.

Again, these observations coincide with those of others commenting on the public policy process, such as Anderson who states that the most common style of decision making in the (American) political system is bargaining [1984:66]. He views bargaining as a process where two or more people adjust their at least partially inconsistent goals to establish a course of action that is acceptable, but not necessarily ideal, to both parties. Bargaining, therefore, involves negotiation, give and take, and compromise in order to reach a mutually acceptable position.

No bargaining can occur, however, unless all participants are willing to negotiate, have something to negotiate about, and have something, that is (technical) knowledge, that the others want or need. Yet, in many instances, the only "resource" that is subject to bargaining is the real or perceived political influence that one group or another has over the policy selection or implementation process [Smith 1990]. Hence, while the parties typically involved in most land management issues comprise a variety of partially autonomous groups, they are also interdependent and must in the end, like Sabatier's model, bargain with one another for mutual advantage, even if initially the results are often vague or ambiguous, expressed in such phrases as "future support" or "favourable disposition".

USE OF JUDGEMENT

Mintzberg et al. hypothesise that the lack of analysis is due to the evaluation and choice process being "inexorably intertwined". In only 18 out of 83 evaluation–choice activities could evaluation be distinguished from choice, leading them to totally reject even the most pragmatic normative description of formal evaluation through analysis by technocrats followed by managerial choice through judgement and bargaining. They therefore conclude that "judgement seems to be the favoured mode of selection" [p. 258]. Hammond et al. [1975:272] do not find this conclusion surprising for, as they suggest, when causal ambiguity is present (as there must be in the satisficing, non-exhaustive policy decision process) judgement must be exercised, as opposed to choosing when the alternatives to be maximised are known.

The exercise of judgement, whether individual or collective, for reaching a decision, will be influenced by the preferences and standards, that is, the political, organisational, policy or personal values of those involved. Of these, the decision makers' personal values are probably the most direct and persuasive criteria for deciding what to do. Public officials and politicians often develop strong commitments to particular ways of handling given problems, or have strong personal views and have already made up their minds [Annells 1987]. .Judgements may therefore be strongly biased and not swayed by facts or information save for those that support their position. Policy choice through judgement is therefore, akin to heuristic models of decision making wherein decisions may just happen – bearing little resemblance to the policy options presented or other relevant information.

Other influences such as political party affiliation [Graham 1987], constituency interests, public opinion, or deference to the judgement of others, particularly superiors, may influence the choice of policy [Anderson 1984:61]. Selection through judgement, then, may not be particularly rational by scientific norms, but, as was argued in the previous chapter in the context of problem solving, in the end choosing what is wanted, as opposed to how to achieve it, can only be a substantially rational task.

BARGAINING, JUDGEMENT AND INFORMATION

Compared to the rational evaluation and choice routines contained within land information systems, the use of bargaining and judgement may appear to be particularly crude, value laden and subjective. It runs very much counter to the prevailing faith of many that reasoned arguments, analysis and choice constitute the way to reach a decision, to resolve a problem. Yet, as is discussed in Appendix A2, there are other equally acceptable means for drawing conclusions, and alternative criteria of choice by which to make a policy decision. Ultimately, whatever method is used in the evaluation–choice process for selecting the preferred policy option, the choice has to be capable of being defended (politically) against all comers and thence be legitimised. As Ray [1990:61] comments "no matter how informal the process, policy making involves the use of reasoned arguments that transform information and give it meaning in relation to particular aims." Thus, for example, when bargaining, the problem has to be stated, information and facts about the problem shared, possible solutions exchanged, statements challenged with alternative facts, information and argument, and, eventually, a policy addressing the problem decided upon. Each "part" of this process involves at least some "information processing" of one form or another.

Hence, irrespective of whether a policy is chosen through bargaining, judgement or analysis, while it may give rise to different requirements for information, structured and used in different ways, each decision process relies on the availability of information in one form or another. This use of information in policy decisions will be further explored in the next chapter.

Summary

Viewed from a land information systems perspective, public policy decision making is bound to appear (and is) a complicated process; surrounded with so many human related and random variables, that the process clearly defies any type of structured or mathematical simulation. Given the wide variation in types of issues dealt with, the generally all-pervasive nature of land management policies and the extreme differences between affected interests, the public policy process is, and will remain, an intrinsically political activity, where perceptions of information and decision making are very different to the tasks to which land information systems are normally applied.

In conventional applications of land information systems at the management (problem solving) level we can talk of defining goals and objectives (usually through some planning process) in organisational and operationally useful terms. In public life, however, what is most commonly acknowledged as a problem or what constitutes a solution cannot be determined in such absolute terms. The ends, as well as the means are likely to remain fluid, in a constant state of flux throughout the policy process. The legitimate arena for their definition and resolution is the normal political process rather than some explicit strategic planning exercise based on "scientific" problem solving methods yielding tangible targets for observation and evaluation. This is not to say that strategic planning does not take place, but it is just "that there is nothing special about such a practice" [House 1982:37].

The process of defining and formulating the ends to be attained in the resolution (solution?) of public problems is therefore of necessity different from that which normally prevails in private where issue-areas are narrower and the solution process more controllable. Thus, it becomes much more a process of deciding how it should be done rather than what ought to be done. It is also a question of who benefits and who pays. These types of question may require far more attention than those asking which is more efficient or yields a greater cost-benefit [Quade 1982: 10].

Yet, once a decision has been made by government to take up a public issue, that is, place some selected reality or perception of the problem on the decision agenda, policies have to be formulated to resolve, impose or alleviate at least some of the issues involved. But as the decision to adopt or not to adopt one reality over another is a political process and therefore surrounded by political uncertainty and doubt, courses of action (policies), like goals, cannot be absolute. Just as bargaining "remains the only known way of generating policies out of a welter of conflicting interests, ill-tested theories, and differentially distributed resources" [Majone quoted by Dery 1984:35], so equally goals may be changed by bargaining during use. Looked at in another way, as the goal may be surrounded by uncertainty but there may be a political need to resolve or de-fuse the issue, to an extent decisions precede definition and problem understanding. Thus both the policies and their purpose may be ill-defined, (1) because of the uncertainty associated with the choice of problem (issue) to act upon, and (2) because the chosen problem may not have an operationally valid goal definition. Yet because there may be an overriding need to act, or to be seen to be acting on a public issue, the general purposive hierarchy of top–down goal setting in the private field tends to be inverted in the public sector to a bottom up action–goal setting sequence. The means and the ends of public problem solving are therefore virtually inseparable, with one yielding an understanding and an advancement for the other.

In this situation, of primary importance in the problem solving process is the acquisition of information to increase understanding of all aspects, of all factors contributing to the issue and possible means for its resolution. The principal features throughout the process of resolving the issues will remain political, however, and better or more technical input will be likely to have little impact on the decision process. Agreed policy positions will be achieved through negotiations and bargaining, the exercise of judgement and reasoned argument. All are information- and knowledge-based activities but again more for learning and understanding; for winning rather than for being scientifically correct, for persuasion rather than for logical argumentation in its own right.

Public land-related policy decisions are amongst the most politically sensitive issues facing government and elected officials. Perhaps even more so than in other public policy fields, the issues will be addressed and decided by the processes and means described above. It appears that analysis, and by implication scientific data and methods as a whole, usually hold little sway in determining policy directions. There is little room in the public policy process for the product of land information systems. While this is true in the rationalist sense, there is a need for good intelligence on all aspects of the policy process. It would therefore be somewhat surprising if land information systems could not make a contribution to this process, albeit differently, and not in the way it contributes to the applications with which it is presently linked. These other ways in which land information systems could assist in the policy process are the topic of the next chapter.

CHAPTER 7

UTILISATION OF INFORMATION IN THE POLICY PROCESS

> People assume that if information is disseminated, others will acquire it, and having done so, it will be used. There are, in fact, chasms between each of these activities.
>
> Donald Michael

Introduction

In looking at how information and decision making process may be related prescriptively and behaviourally, the last three chapters identified some shortcomings in existing land information systems for public policy making and started to isolate the characteristics that a land information system should possess for it to be of value and benefit in the policy process.

This chapter develops a set of formal tools and methods derived from the knowledge utilisation field to determine how, to what extent and to what effect information is used in the public policy process concerning land. This is achieved by applying these tools to the characteristics of public policy and decision making described in the previous chapter. The result is a description, with all the limitation and imprecision that any "measures" of the public policy process entail, of how the availability of formal information and knowledge about land influences the policy process and its outcomes. These in turn are then used to refine the features required of a land information system to serve the needs of the policy process.

Following a discussion on the methods that have been researched to identify the connections between information use and the policy process, three specific measures of utilisation will be proposed for this study. To begin, some causative measures by which to estimate the effect of the absence or presence of some information or knowledge in the policy choice process will be proposed. These measures will then be used to gauge how information is being used in the public policy process as observed by the Mintzberg et al. [1976] model described in Chapter 6. Similarly, means to describe the intensity of land information use and the impact of that use on the public policy process will be developed and applied to the decision and policy models advanced in earlier chapters. Lastly, some general observations and inferences on information utilisation in the policy process will be drawn.

To begin, a number of theories developed through research on knowledge and information utilisation in public decision making will be examined in order to describe the origin, strengths and limitations of the knowledge utilisation, influence and impact tools to be used later in the chapter.

Some Definitions of Knowledge Utilisation

There are various classes of theories and perspectives on how information and knowledge are utilised in decision making, differing even to the extent of what is meant by the term utilisation, and (as is discussed in Appendix A1) what is meant by knowledge and information. Thus, for example, Rich [1977:200], in discussing the utilisation of research in the policy process defines use as "information entering into the policy process". Havelock [1975:88] refers to knowledge (as opposed to information) extending Rich's definition by concentrating on how knowledge is received, transformed and consumed once it arrives at the recipient. Glaser et al. [1983:2] take the view that knowledge utilisation "refers to the application of available knowledge or technology by a new user and, in some cases, to a new use". This later meaning of utilisation does not discriminate between new or original knowledge and pre-existing knowledge, it is only concerned with whether it is used.

In this study we are basically interested in how land information is utilised in public decision making concerning the use and management of land. Thus, like Booth [1990] we are interested in finding out whether the application of information available in a land information system makes a difference to what happens to the process. This entails, amongst other things, establishing whether the information is partially or fully accepted as part of the decision makers' stock of knowledge that is brought to bear on the resolution of the problem.

Two other terms, adoption and diffusion, will need to be defined if we are to gauge the use of formal land information in public problem solving. Glaser et al. [1983:2] refer to *adoption* as the early stage of acceptance, with implementation referring to its firm execution. They take *diffusion* to mean the deliberate spreading, especially by contact, of some piece of knowledge or innovation. It contrasts with the term dissemination, which Glaser sees as meaning a wide dispersal or spreading of knowledge transmitted by non-deliberate, incidental or osmotic processes. In this terminology, then, land information may be adopted (accepted) but not necessarily used; that is, no action (implementation) results from its presence. Similarly, information from a land information system may reach a potential user through either a diffusion process (the method normally used) or through dissemination. The discussion later in the chapter will demonstrate that, contrary to the common belief, it is adoption and dissemination rather than implementation and diffusion that are the more significant process for understanding the utilisation of land information products in the public policy process. This again runs counter to the general belief of the land information systems community.

Some Theories of Knowledge Use

Groups concerned with the study of knowledge utilisation employ differing concepts and units of analysis, depending on their disciplinary biases, to search for the factors influencing utilisation. Not only does this result in a great diversity of views, but also at times conflicting findings, definitions, and range of utilisation factors. Each perspective has some relevance to understanding the place of land information in the public policy process and will be briefly discussed.

UTILISATION – ORGANISATIONAL PERSPECTIVE

Rich and Goldsmith [1983] look at utilisation from an organisational perspective and suggest that meaningful knowledge is tied more to issues of values and maintenance of power than to the "objective, technical" quality of the information. Thus

> the usefulness of information has more to do with the characteristics of the person who possesses it (i.e. an expert) than it does with the substance of the message that is being conveyed.

They argue it is expertise that is the primary source of bureaucratic power; that what knowledge is selected and how it is used will be strongly influenced by the agenda and perspectives of experts [Benveniste 1977]. These arguments are similar to those advanced in the previous chapter regarding the importance of winning rather than being technically correct or complete.

UTILISATION – TWO-CULTURE PERSPECTIVE

Havelock [1975:89] takes the problem of knowledge utilisation as being one of linkage, and communication between the hard sciences and the social sciences, between the narrow specialist and broad disciplinarian, between research and practice.

This two-culture metaphor implies the existence of differences in values, beliefs, motivations, incentives and the like between two communities, in our case between the land information and policy fraternities. The view implies that information from a land information system will probably have to be restructured or translated in order to place the relevant information and the policy problem "in the same information system so that there is a communication channel and an interconnection" [Parker 1975:29] or, in the words of Glaser et al. [1983:3], that the knowledge "reached the people who need it in a form that they can put it to use". Improved knowledge utilisation therefore becomes a question, for example, of closing the gap by introducing knowledge in a "usable" form, providing some kind of bridge between the social and policy maker perspectives [Caplan 1977:196, Linstone 1984].

This raises a number of issues that the land information community will need to acknowledge and address if indeed it wishes its information systems to be gainfully employed in the public policy process. Chapters 8 and 9 will examine these factors in some detail.

UTILISATION – CHANGE PERSPECTIVE

A third view, and one that will be adopted in Chapter 10 to summarise the place of land information systems in the public policy process, rests on the large amount of research where knowledge utilisation is taken to be synonymous with planned change or innovation. This research focuses on the process of knowledge diffusion, where use is interpreted to mean the re-invention, adoption, adaptation or rejection of specific technologies or ideas [Rich & Goldsmith 1983:95].

A consolidation of the literature on this perspective, amongst other types of knowledge use, was performed by Glaser et al. [1983]. It brings together, and compares, four major studies formulating the variables that effect change (nay, utilisation) based on the A VICTORY model of Davis and Salasin [1975]. This behavioural model of change is an adaptation of learning theory embracing such aspects as drive, motivation, ability, learning capacity, circumstance, etc.

Eight factors influencing the likelihood of adoption and adaptation of a change, form the A VICTORY model. A brief description of each is given in Table 9.1. The table is a blend of the variables identified by Davis [1973] and the models proposed by Glaser [1973], Zaltman [1973] and Havelock and Lingwood [1973] as described by Glaser et al. [1983:36]. Glaser et al comment that the A VICTORY mnemonic is considered by Davis as "necessary and sufficient to account for organisational behaviour related to the utilisation either of promising new knowledge or of validated innovative procedures/practices/products". Clearly land information systems and its aspirations to improve all land management decision making processes falls into this category.

Proponents of this view of knowledge utilisation suggest that their empirical findings have a wider utility and applicability. Studies and literature from allied fields (e.g. Lohuizen [1986], Quadrell & Rich [1989], Roberts-Gray & Gray [1983]) lend support to the efficacy of the change factors identified as general indicators of the conditions that are conducive to knowledge utilisation.

LIMITATION OF UTILISATION THEORIES

Each of these perspectives (the organisational, two-community and change perspectives), like this study, is attempting to establish a framework; a means by which to find tangible evidence of use/influence/impact of some piece of information/knowledge in the public policy process. Most of these theories assumed that there is a one-to-one relationship between the input of some information and a resultant difference to the outcome even though, as multiple studies have indicated, such an assumption is a gross simplification (e.g. Holzner et al. [1987], Dunn et al. [1987]). Once a simple input-output model is abandoned, Dunn et al. observe that "due to the extraordinary complexity of the social arrangements governing knowledge-related activities in contemporary society", alternative systems "yield no firm conclusions about the specific indicators that should be included in a knowledge systems accounting perspective". Their findings are echoed by Rich and Goldsmith [1983:107] "in attempting to investigate a less straightforward relationship between information and utilization, formidable methodological difficulties present themselves."

These doubts are echoed by Booth [1990] who reports that the consistent thrust of these studies indicates that the effects of land information systems will be "diffuse, indirect, hard to pin down, and often scarcely visible, if not imperceptible." Like Booth's research findings, land information systems consist, in the main, of explicitly structured, logically deduced knowledge formally presented in computer generated print-outs and maps. If we take the use of research data and land information to be analogous, then Booth's comments on the shortcomings of the methods used to explicate the function of research in the policy process also apply to this study. For our purposes these shortcomings may be interpreted as follows.

1. Land information will generally be merged with and become indistinguishable from other sources of knowledge and policy inputs.

2. Users themselves will generally be unable to separate out what they have learnt from land information system from their general stock of knowledge about an issue or a problem. They do not catalogue it separately but blend it into their overall perspective.

3. Policy making is not a one-shot, analytical event, but more like a slow process of evolutionary development. There is therefore no moment of impact or application on which to focus; hence it becomes very difficult to know where to look for evidence about the use of land information or how to trace its consequences.

4. Information will creep into policy in diffuse ways.

There are, therefore, substantial methodological barriers and dilemmas involved in using the present methods for assessing the specific or unique contribution that land information systems make or could make to the policy process. Yet, neither Booth nor Rich [1991] in a stock-taking of the knowledge utilisation/diffusion field over the last twenty years, can offer any significant alternative methods. Booth suggests that case studies or inside accounts may offer some benefit, but later rejects them, while Rich concludes that "there is an open agenda in the field of knowledge utilisation with many unanswered questions." The tools we have for measuring the connection between land information and policy are therefore limited in their extent and precision, yet they are all we have. But, as will be discussed in the next section, the broad categorisations of utilisation advanced by researchers like Rich, despite their deficiencies, provide a significant pointer to how we should view the place of land information systems in the policy process.

Evaluating the Use of Land Information in the Public Policy Process

The research on knowledge/information utilisation leads to three broad measures, namely: information use; information influence and information impact which may be helpful in explaining the place of land information systems in the public policy process. These tools, together with the results of three studies (Kraemer [1987], Zwart [1988, Appendix C5] and Smith & Wellar [1992]) will be employed to investigate the characteristics of land information usage based on the models developed in the previous chapters. The overall aim, like those of knowledge/information utilisation studies in general, is, as stated in Chapter 1, to test the normative assumptions that:

1. It is *a priori* valuable to use information which is made available to policy makers.

2. Society, as a whole, will benefit from the use of available information.

3. Policy makers' decisions concerning utilisation should be guided primarily by assessing the quality of the information provided and not by political and bureaucratic considerations [Rich 1991].

MEASURING USE

<u>Instrumental and Conceptual Use</u>

To measure how information is used in the policy process, the broad indicators of instrumental and conceptual use of information use will be employed. The distinction between these two types of use recognises that different types of information will be used differentially, and acknowledges that the presumed one-to-one cause and effect relationship between an action and the presence of a particular piece of knowledge, is flawed. Such a preoccupation with the action implications of knowledge overlooks

> the significance of other political and organisational functions that knowledge may serve;
> (1) organisational learning and planning, and
> (2) beginning to influence the way in which problems are defined and specified.
>
> [Rich 1977:209]

To distinguish this later use of knowledge from that employed to initiate an action, Caplan et al. used the terms "instrumental utilisation" and "conceptual utilisation" to differentiate between the textbook model of applying specific knowledge (or research in his case, land information system information activities in ours) to a specific problem, and, on the other hand, the consciousness-raising effect of the use of some knowledge [Caplan et al. 1975:17-20]. As Peltz [1977:3] puts it, instrumental use effects a specific decision or action whereas conceptual use brings about a change in awareness, thinking or understanding of some concerned audience. It's what Churchman [1975:33] calls suggestive information, "suggesting" some aspect of the situation with which he [the decision maker] may not be familiar, which may or may not be relevant. Its function is also, as Hogeweg-De-Haart [1984] remarks, that of giving certitude more than of answering to any particular cognitive need. We will return to this question of providing certainty later, as it is one of the prime ways in which land information is used in the public policy process.

Caplan [1975,1977,1979], Knorr [1977], Rich [1977,1979] and Weiss [1977,1980] have all interviewed large numbers of public policy decision makers at the State and Federal levels of governments in the US to empirically determine how social science research knowledge is used in the policy process. Many of their findings are transferable and may explain how land information is used in the policy process. They may be summarised and compared to the Mintzberg et al. [1976] findings as detailed below.

Instrumental Use

The instrumental application of knowledge dominates the thinking about how knowledge is utilised and how its use may be proved, and leads to a technological conception of knowledge use. This is also reflected in the land information systems community's thoughts on how its information is used. While such direct instrumental benefits of land information systems, such as more consistent information and comprehensiveness of analyses, are in evidence (Appendix C5), there is no evidence in the literature, or discussion on anything but instrumental use. Other types of use or benefits accruing from information have received scant attention, especially in any formal or explicit way. Exhortations like those of ALIC [1988] to ensure increased use of land information in the policy process are, while unqualified, instrumental in intent.

This emphasis on utilitarian use is due in large measure to instrumental use lending itself to empirical study, and therefore receiving more attention at the expense of other forms of knowledge use. In part, this is also due to the effects of uses other than instrumental being less predictable. Hence, as Caplan states, the major problem is not how to increase the amount of instrumental application, but "arises from the fact that scientific knowledge use in public policy is not fully realised because of this emphasis only on the most practical aspects of its value" [Caplan 1979]. Changing this emphasis, or at least acknowledging that information does have other uses, and can bestow other benefits besides those of immediate value in a problem-solving process, may not only extend the usefulness of land information but may also have a direct bearing on how it should be structured, presented and applied. To examine this proposition further the link between conceptual use and how we acquire knowledge will be considered.

Conceptual Use and Learning

Conceptual utilisation, while generally going unrecognised, or at best being referred to obliquely, may have a considerably greater use and influence than instrumental information and knowledge. For example, as Mintzberg et al. [1976] observe, once a decision process is initiated, i.e. the existence of a problem is acknowledged, a diagnosis takes place, the first step of which is "the tapping of existing information channels and the opening of new ones to *clarify and define* the issues" (emphasis mine) [p. 254]. Thus, as Kraemer [1987] notes, despite receiving regular reports, local government officials and policy makers, when faced with new problems and concerns, will "initiate ad hoc requests for special comparison reports, exception reports and computer listings" to broaden their understanding of an issue.

Conceptual use provides enlightenment [Lohuizen & Kochen 1986] as well as supplying "the contexts from which ideas, concepts and choices derive", permitting decision makers to gain a "general direction and background, to keep up with developments in the field and to reduce uncertainties about their policies and programs" Weiss [1980].

This is illustrated by Mintzberg et al. in the "comprehension cycles", one of the dynamic factors identified by the study where the main use of information and knowledge takes place. As stated earlier, strategic decision making processes are not sequential, but more of a circular process, with the decision maker cycling within or between routines until he "gradually comes to comprehend a complex issue", especially in those decisions that are novel or complex [p. 265]. A heuristic trial-by-error solution is adopted to reduce or eliminate the uncertainty surrounding both the problem and its solution.

This is achieved through a learning process of gathering knowledge and experience by trying a number of goals, decision structures and alternatives to gain understanding and to make sense of the decision. In the Mintzberg et al. model these activities are supported by the decision communication routines consisting of exploration routines involving scanning for and reviewing information, plus investigation routines comprising "focused search and research for special-purpose information" [p. 261]. Consequently, "much of the effort is ... centred around merely delineating the issue in a way that enables some usable results to be obtained from the information at hand" [House 1982:27].

These findings closely modelled the cognitive and behavioural prescription provided by psychologists on how we acquire, process and exhibit knowledge. Instrumental use of knowledge with its specified goal or action is equivalent to reception learning, where what is to be learnt (to be done) is available in its final form with the results of the learning (action) measured by changes in behaviour [Gagne et al. 1988, Zwart 1975].

Behavioural change as a result of discovery or incidental learning, on the other hand, is much more difficult to measure as no goal has been set (or not as yet finalised), so that "the principal content of what is to be learned is not given but must be discovered by the learner before it can be meaningfully incorporated into the student's cognitive structure" [Ausubel 1978:24]. This has led El Sawy [1985] to use the terms accommodation information (conceptual) and assimilation information (instrumental) to describe the strategic information search behaviour of chief executive officers of medium to small high technology companies. He describes accommodation information as enabling chief executive officers to later interpret specific information differently and as "wisdom-increasing" information, while assimilation information is more specific in identifying strategic threats and opportunities.

Thus, Mintzberg et al.'s strategic decision makers generally scan for information and passively review what comes unsolicited "to identify decision situations, to build conceptual models, and to develop a general data base for decision making" [p. 261]. Similarly, Weiss [1980] refers to the complex process of assimilation whereby information is interpreted by users "in the light of their other knowledge and they *merge* it with all the information and generalisations in their stock" (emphasis in the original).

Conceptual Use and Land Information Systems

Mintzberg et al. and Weiss are, in fact, referring to discovery learning, which is quite different from the normal reception learning as the learner must rearrange information, integrate it with existing cognitive structure and reorganise these newly integrated combinations of information to arrive at a desired end-product. It means that essentially a problem-solving technique is being employed to acquire knowledge.

Acquiring knowledge in this manner is not aided, however, by highly structuring the information on the basis of some set, surrogate representation, drawn from one perspective, as is the case with land information systems at present. When we are spontaneously exposed to an unfamiliar or new situation we tend assimilate the most general ideas first and later refine these to greater levels of detail, if and when required [Zwart 1986c]. Yet, land information systems generally hold their information at the most discrete level possible, organised in layers according to standards and protocols determined by some specialised, expert community(ies). Since the information in a land information system may be organised quite differently to the recipient's cognition, meaningfully linking the supplied information may become problematic and a protracted task, since real understanding will not occur until we are able to tie the new information into our existing cognitive structure.

What I am suggesting is that the organisation of information in a land information system is generally not compatible or conducive to conceptual use. If, as the foregoing evidence suggests, conceptual use of land information is likely to be significant in the policy process, then changes may have to be made in how we think about, and organise, land information systems. They may need to be viewed from a learning perspective, structurally and contextually; as an inductive learning system rather than a deductive information system. Hence, as Enache [1991] urges, land information systems have to "educate the participants by providing guidance in the subject matter"; become problem-oriented, not solution bound. If we can view land information systems from this stance, then their use, even though it may be in a conceptual mode, is likely to be high and of some moment in the public policy process. As Bruner concludes, "the most uniquely personal of all that [man] knows is that which he has discovered himself" [1961:22].

How land information systems could be modified to fulfil this learning role will be covered in the next chapter.

Conceptual Use and Problem Solving Information

Cognitive psychology, therefore, provides a framework and a backing for the empirical findings on how we acquire, process and subsequently use instrumental and conceptual information. These findings also show the connection between knowledge structure and knowledge use, and the need to acquire information on both.

The Mintzberg et al. model acknowledges this need in its decision routine. Firstly, it characterises the stimuli that evoke a decision process on a continuum with, at one extreme, the *opportunity decisions* (purely voluntary, improvement seeking decisions from a secure position) – the problem as an opportunity (Appendix A4) – and at the other extreme *crisis decisions* (where organisations may be under intense pressure). In general, and perhaps not surprisingly, the quantity and quality of information use in all routines diminishes towards the crisis part of the scale.

Secondly, the authors classify decisions by solutions ranging from whether the solution is *given* – that is, fully-developed at the start of a process – through to *custom built*, where a special process has to be designed for the system. During the development phase, decision makers designing a custom-built solution perform extensive searches but only fully develop one solution by restricting themselves to one branch of a decision tree containing all possible solutions, "apparently, because design of custom-made solutions is expensive and time consuming, [hence] organisations are unwilling to spend the resources on more than one alternative" [p. 256].

On the other hand, when solutions are given or need only a slight modification – that is, where there is a minimum requirement for knowledge structuring – "organisations are prepared to fully develop a second solution to compare it with the first" [p. 256], since the decision maker may, without prejudice, be selective in the extent of the information he seeks for the first solution. Accumulated knowledge and experience from previous decision processes allows "common sense shortcuts" to reduce the number of alternatives "by means other than the laborious covering of ground already trodden" [Pfiffner 1960:130]. Knowledge of the activities of the complete system is no longer necessary, as the problem reduces to an incremental step. Consequently, the "search for any broader perspective on the situation should be considered a waste of time and energy" [Winner 1977:291], as it will only add unnecessary, unwanted complexity and uncertainty.

Custom building solutions, therefore, largely become a conceptual activity, as much a task of understanding the solution process as the choice of solutions. Using or modifying an existing solution, on the other hand, reduces to mainly an instrumental exercise. As Wilensky writes, "The greater the cost and risks or uncertainty and the more significant the change in method and goals involved, the more intense is the search for information" [1967:78]. Hence, as the problem solution moves away from the structured end of the spectrum, the greater the need for conceptual knowledge, i.e. for learning about the problem itself. The converse also holds.

As a result, although the amount of information required appears to be fairly static, the kind of information needed (i.e. structuring or context information, as distinct from values or descriptions of some event or object) will change according to how the solution process is selected. As Witzling comments, the information gathering activity as an act of learning "suggests that the roots of such an activity extend far beyond the concerns of an immediate problem-solving situation" [1976:82], and may equally need to extend over a considerable period of time [Sabatier 1987].

The ability of a land information system to cater for these concerns, as discussed above, is perhaps questionable and will be explored in more detail in the next chapter.

<u>Utilisation Time Frames</u>

Up to now utilisation has been taken to be a static, one shot affair where the information is either utilised (conceptually or instrumentally) or not utilised at all. Utilisation may also be viewed, however, in terms of short-term and long-term use where, as commonly occurs, the short-term, first wave use corresponding to instrumental use is oriented towards action inputs represented by "the discrete bits of information that are used to fill-in and support the overall perspective" provided by the conceptual, second wave knowledge [Rich 1977]. Alternatively, instrumental knowledge collected for a particular decision may be placed in a "holding pattern" to become part of the conceptual knowledge for a future decision. This tendency is inherent in the classical decision making process (Chapter 4) wherein instrumental information collected for the problem definition phase (the decision preparatory role [Knorr 1977:171]) forms the conceptual knowledge, the focus for the policy formulation and decision stages.

Mintzberg et al. [1976] report, for example, in their the recognition routine that a stimulus for a decision "may remain dormant in the mind of an individual until he is in a position to act on it" [p. 253]. An action is unlikely, however, until some further stimuli (in the form of information) have accumulated to a certain "action threshold"; that is, a problem will not be acted upon or placed on the decision agenda until the combined stimuli reach a perceived amplitude. To accumulate to this threshold amplitude, stimuli need to be frequent, clear and consistent, acting as mutual reinforcements, otherwise the perception of the need to act may decay [p. 253].

Until sufficient knowledge has been accumulated to reach this threshold, the information contributing to it will have been received, but not acted upon: i.e. it will have been fulfilling a conceptual/understanding/ awareness role until its instrumental use at the time of action. Accumulating knowledge is a non-instrumental use of knowledge and information, so in such cases conceptual use of information precedes instrumental use and may be the more significant of the two in the decision process. This conclusion parallels the findings of Pelz in his study of the utilisation of environmental knowledge in municipalities in North Michigan, where he observes that "it often appears that *conceptual use must precede instrumental use*" [1977:76] (emphasis in the original).

Over time, then, in a policy decision making process, information from a land information system may play an instrumental role and/or a conceptual role; in no particular order. Identifying how some information is or is not used, will therefore need to be assessed and judged over what may be a protracted period. Thus, there is a need for "utilising time frames" of perhaps a decade or more in order to complete perhaps one formulation–implementation–reformulation–decision cycle [Sabatier 1987] to allow for differences in type and level of utilisation over time [Rich & Goldsmith 1983:107].

It will therefore be difficult, irrespective of whether the utilisation is instrumental or conceptual, to say with any certainty whether some piece of information derived from a land information system has been used, is about to be used, or may be used again, perhaps in a different mode or in a different context. All that can be stated is how the information has been utilised up until some particular time, plus the likelihood that it will be used within some given time in the future.

Utilisation and Informal Information

Policy decisions, as noted in the last chapter, rather than relying on a single piece of information or a particular type of information, are likely to rely on assessments of both hard (scientific) knowledge and soft, informally acquired knowledge from a variety of sources. These are then combined conceptually to form a perspective or a judgement for broad application at the policy level. Hard knowledge, particularly when quantitative and couched in scientific language, is usually only of instrumental importance, whereas soft, qualitative knowledge expressed in layman's language is likely to be a much more influential determinant in the selection of policy options. This is particularly so because, irrespective of what kind of information is being sought or how it is used, "there is evidence that investigation in strategic decision processes relies largely on informal, verbal channels of communication" [Mintzberg et al. 1976:261].

Informal sources generally tend to provide background and contextual knowledge, but in many instances may also be the information that actually triggers a policy process or a policy choice. However, as noted earlier, to ask a decision maker to identify instances of use of particular items of information is like asking him to "atomise his conception of social reality, to take knowledge out of context, a context without which the knowledge would not have been retained in the first place" [Caplan 1975:19].

Given Mintzberg et al.'s observations, and, for example Kraemer's [1987] findings that "top decision makers" in local government make only occasional use of computerised information systems for such activities as problem finding and "conceptualising broad problems", it is clear that informal information sources are predominant in the policy process. While the utilisation of information obtained in this manner is not of direct interest to this study, there is some evidence to indicate that information from land information systems may also find its way into the policy process, second hand, through such informal channels, particularly when the issue is highly contentious [Smith 1990]. This dissemination as opposed to diffusion process adds an extra layer of complexity to trying to establish a link between the policy process and the place that land information systems may have in it.

Symbolic Information Use and Legitimation

Before leaving the question of how information may be used, there is one special kind of instrumental use that needs to be noted, namely, the symbolic use of information to (usually) legitimise a prior decision made by some other means, based on some other knowledge or information than that with which the decision is publicly linked or associated. Although it is only obliquely referred to by Mintzberg et al. [1976:264], there is a large body of evidence, both for land management decisions (for example in Annells 1987, Healy & Ascher 1990, and Smith 1990), and from other policy processes, suggesting that this type of information use is frequent and occurs at all levels of public decision making. There is no evidence to suggest that the use of land information in this symbolic/legitimation role is not at least as prevalent as in other areas. Identifying such uses may therefore be significant in understanding how land information systems may be employed in the public policy process.

The roots for using information in this manner lie in the cult of the rational [Rozack 1986], including the perceived superiority of reasoned, "factually" based arguments and conclusions over all other forms of problem solving (as discussed in Chapter 3, and elaborated in Appendix A2). Thus, information, and particularly computer based information serves "important symbolic functions, particularly in promoting the image of rational decision making and invalidating certain policy choices" [Danziger et al. 1982:168]. Their use creates the appearance of rationality and modernity, as well as enhancing the status and prestige of the user.

Just the mere appearance of more and better information, as Weisband [1985] observes, justifies the decision to adopt these sources, even when the computer process data does not ensure that decisions will improve, or even that information will be used. If it is used, it may be only as a symbolic element, "used because it convinced important parties that decisions were being carefully made; ... [used] to gain more credibility" [Kling 1980]. While this may not have been the original or intended mode of using the computer system or the information it contains, it nevertheless represents a direct (instrumental) use of the information, and the system that contains it, and is therefore, of importance to this study.

Kling [1980] goes on to observe that this symbolic aspect of information use need not be to the exclusion of its rational use. "People will respond to rational and symbolic issues in parallel, or at different times and in different situations". For the reasons discussed earlier, it may be more difficult to identify, in either conceptual or instrumental terms, this rational use as distinct from the symbolic use. An apparent, inappropriately high symbolic use of information may result.

Besides symbolising rationality and status, computer based information and analyses are often used in what Dutton [1982] calls the "decision–propaganda–conformity" sequence. Here decisions have already been made and information is produced to support a decision in convincing others to gain the necessary support for its adoption. This decision legitimation effort is commonly characterised in a pejorative sense, being portrayed as a means to justify and gain support for a selected policy response, which might not stand on its own merits [Weiss 1977, Knorr 1977]. However, some like Kraemer and Kling [1983] argue persuasively that retrospective analysis is a necessary and positive phase of the policy process, and that such "policy argument" serves to inform relevant actors of the appropriateness of the decision and guide their application of the policy.

In fact, as Kraemer [1987] suggests as a result of surveying 40 major US local governments, computer based information is quite widely used in policy argument as a key source of *evidence* – "information selected from the available stock and introduced at a specific point in the argument in order to persuade a particular audience of the truth or falsity of a statement of fact". Once credible, supporting information for the selected policy has been acquired from the computer information system, it is normally "given considerable visibility because most actors place high credibility in automated information, and as a consequence, are more likely to accept the efficacy of the policy argument it supports". But as Healy and Ascher [1990] point out, this may not always be the case. When the US Forest Service attempted to legitimise its position on the forest resources debate through extensive information processing and analysis, their opponents used similar techniques and technology to expose their underlying hidden assumptions and agendas.

Legitimation and Land Information Systems

Using information systems to legitimise positions or decisions is of course quite different to the goal–choice–means cycle typified in the prescriptive decision models in Chapter 5. Instead, the reverse of a routine decision making model is used in the legitimisation process where, starting from a predetermined choice, the system is asked to either seek out evidence that plausibly links this choice with (1) a preset goal or (2) with some new, but acceptable, alternative definition of the issue or problem which also fits the preferred policy option and the information within the system. Importantly, from our point of view, if a land information system is being used in this legitimation mode, it is being used (instrumentally) in the policy process, even though it may not be in the rationalist tradition. Furthermore, as the decision maker is scanning the land information system for specific supporting data, the link between the use of the information and a particular policy choice may be direct and clear to the decision maker, who then has to articulate and demonstrate the connection to others.

This presupposes, of course, that land information systems can be used in the symbolic, pre-decision justification mode. Many conventional land information systems, however, already have difficulty in extracting information of benefit for policy making [Humphries 1985]. It cannot be taken for granted that land information systems will necessary be able to provide, or be proficient at providing, information for legitimation purposes.

Firstly, searching through a land information system for information to support a particular policy option is a different task, operationally and technically, from using the information within the system to identify a number of policy options. Land information systems are designed and structured to perform the latter deductive task, not the former inductive operation. (The implications of "reverse engineering" decision choices on the structure and operation of land information systems will be explored further in Chapter 9.)

Secondly, using land information systems in this mode assumes that the system contains the information that can bestow credibility and legitimise the chosen decision. But, given the type, source and nature of information typically held in a land information system (as discussed in Chapter 2), this may be an unwarranted assumption. Theoretically, land information is validated against some standard, but whether these standards are appropriate for establishing certainty, perceived or otherwise, outside their own narrow, functional domains is questionable. There are limits to the scientific method and hard data, the implications of which will be covered in the next chapter.

DEGREES OF UTILISATION

Distinguishing between conceptual and instrumental use of information in a decision process, indicates the function the information is fulfilling, i.e. whether the information is being used directly in the decision process or just to provide a context and background. These measures of use do not indicate the degree to which the information is acknowledged, used or modified during the decision process. Has the information, for example, been considered by a potential user but then rejected, or has nothing been done with the information except that its implementation is under consideration [Larsen & Werner 1981]?

As the information utilisation characteristics of the Mintzberg et al. [1976] model showed, utilisation is neither absolute nor static, but relative to purpose and continuous. In short, information use is a process not simply attaining one goal at one point in time, "but a series of less than discrete events varying over time and area of application, and dependent on the type of information in question" [Rich & Goldsmith 1983:103].

As part of this process, there are degrees of utilisation which for Weiss and Bucuvalas [1980] translates into a scale of utilisation ranging from no use, ever; through information used, but the decision maker was unable to describe any concrete ways in which it was used; to the information having been used and specific types of use described.

According to Nagel [1988:13], a better scheme for assessing degrees of information utilisation in the policy arena is one based on the usefulness, validity and importance of the information to the decision maker. Holzner et al. [1987] use a similar concept called intensity of utilisation as opposed to the impact the utilisation may have. Nagel, in his case, goes on to suggest that the actual utilisation of policy research studies is best represented by a continuum made up of four stages (Figure 7.1) rather than a yes/no concept.

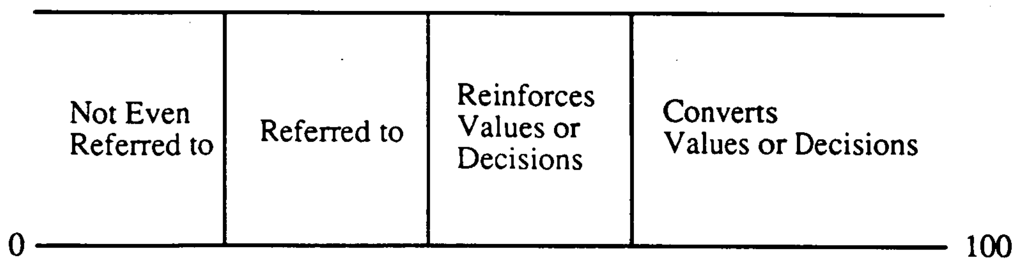


Figure 7.1 Degrees of Utilisation of Land Information
[After Nagel 1988:15]

If we take the results of policy research to be just a particular kind of information (i.e. information about the interplay between government decisions and social problems), then Nagel's model may be interpreted as follows.

1. Utilisation at the lowest level involves producing information that is in no way referred to by people for whom the knowledge was intended.

   In our case, they neither know of the existence of the land information system (i.e. the information source), nor of the information they contain, or perhaps the results of an analysis even though it may have been explicitly designed to serve the needs of the problem at hand.

   For the reasons discussed in the last chapter, the fact that the supplied information may have been totally ignored usually has little to with its quality or relevance but a lot to do with the policy formulation process, how the policy options are prepared, how and by whom it is presented, and whether it instils confidence in the policy maker "to be able to give some version of it to others, often to give the impression that they have the situation in hand" [House 1982:137].

2. At the second lowest level is information that is referred to by the decision/policy maker, but is not influential enough to change a

decision or strengthen a preconceived one. The information has not been of sufficient moment to cause the decision maker to redefine the issue, or dramatic enough to cause a change of alternatives. Thus, while the new knowledge has been used, its impact is low, as the knowledge has not been acted upon.

3. The highest but one level of utilisation, the reinforcement of preconceived decisions for legitimisation, is, as shown above, a reasonably common use of information Those who believe in the functionally rational process of analysis and optimisation may not of course consider this "symbolic" use of information as constituting utilisation. But as pointed out by Nagel [1988] and in the next chapter, under these conditions the information supplies support and credibility, thereby perhaps accelerating the decision outcome and widening the acceptability.

4. The highest level of utilisation occurs when the presence of a particular piece of knowledge causes a change to the initially preferred alternative or defines the problem. As both Nagel and House and Schull [1988] note, changing an outcome is an extremely rare occurrence for the fruits of policy research analysis. Nevertheless, this form of utilisation is the normative view of the land information system community; the instrumental, information for action perspective.

This utilisation scheme is similar to that of Zaltman and Duncan (1971) whose classification distinguishing between information which confirms a decision maker's belief (Nagel's stages 1 to 3), and information which challenges a decision maker's belief (stage 4).

On this four point scale it is possible to define utilisation to be just categories 3 or 4, or including 2 as well, depending on, for example, whether the mention of some knowledge attributed to a land information system in a report without influencing the final outcome is considered utilisation. The land information system community, with its instrumental tradition, would probably say it is not.

Utilisation Intensity and Land Information Systems

Apart from the efficiency, goal defined applications of land information systems at the operational and management levels of land management, there are few recorded examples at the policy level of where results derived from land information systems have achieved utilisation level 4. The most substantial report is that of Kraemer [1987] on use by local government in the USA of computerised information systems for the provision of information regarding policy alternatives.

Kraemer's survey results suggest that *once a set of politically feasible alternatives has been specified*, computerised information can serve as a most important source of information regarding these alternatives; and that it is an area of the policy process in which computer based information systems do have a considerable impact. His data reveals that computerised data have changed or affected the decisions of top policy makers (city managers, majors and councillors), especially managers, in a substantial number of instances. But he goes on to comment that these systems' utility for this purpose has been somewhat limited through the lack of data or because it

> is in automated systems which do not structure data into formats that facilitate their use by top policy makers. In fact, our research indicates that most of the automated information found useful by these policy makers is created by consolidating, sorting, listing, aggregating, or otherwise reorganising the information contained in the many independent applications that support day-to-day department operations.

This, of course, is the same premise on which the land information system community is resting its case for claiming that land information systems have a place in the policy process. It should be noted, however, that Kraemer's observations are predicated on having available politically feasible alternatives: that is, information on policy alternatives is being considered in a politically defined or bounded solution space; which is much closer to the problem-solving end of the decision making continuum of Chapter 1 than to the policy end. This is therefore quite a different context to the strategic planning process discussed by Mintzberg et al. [1976] and the public policy process in general described in the previous chapter. Nevertheless, Kraemer's observations are useful in establishing the conditions under which land information systems may influence policy outcomes.

An example in the land-use area is one described by Niemann [1987], where the results of a land information systems analysis of an alternative land-use classification defeated the original preferred policy proposal, but only after it was shepherded through the public policy process by the analyst concerned and his close legislative supporters. Niemann suggests that unless the results of land information systems are viewed in a political context, they do not have any intrinsic advantage over other information entering the policy process.

This is in line with the fate of technical inputs in general, and analysis and modelling efforts in particular in the public policy process: e.g. House and Schull [1988], Healey and Ascher [1990], Smith [1990]. The factors leading to this generally low acceptance of technical information in the policy process, and some possible steps to increase their acceptability, will be noted in Chapter 9.

The relationship between land information system and reinforcing a preconceived decision has largely been discussed above. It is perhaps worth reiterating that in the land management policy process, the symbolic use of information, and for that matter the symbolic use of planning, are, according to one former departmental secretary responsible for land use advice, very common. The rational use of information "is an extremely rare phenomenon in government in my experience" [Annells 1987].

Turning now to the case where information is referred to but not used to either reinforce or convert a decision, it would appear, as there is no evidence to the contrary, that significant amounts of analysis and model outputs of land information systems fall in this category. Extensive land information systems are being established (Chapter 3), from which copious quantities of information, in all forms, for a range of land-use tasks emerge to enter the planning and policy process. Yet, as commented on above, there is scant evidence of their being referred to at all.

Even given the caveats at the beginning of this chapter on the difficulty of identifying information use, it is still somewhat surprising to find so little apparent evidence of its use in the policy process. Perhaps it is because, as Barry Richardson, the former director of the Environmental Resource Information Network, (ERIN), says

> there is a serious deficiency in the level of scientific expertise in most policy areas ... [decision makers] ... are quite incapable of identifying issues in advance ... or in understanding, interpreting and assessing the limitations of scientific information when it is supplied to them.
>
> [Richardson 1992]

More probably, however, it is due, as House and Schull [1988:198] observe, to scientists (land information system cognoscente) failing to recognise that multifaceted issues, such as those concerning land management and the environment, may not be amenable to comprehensive, sophisticated techniques, for "they are the issues that are least likely to be clearly enough defined and specified to be empirically dimensioned and simulated with any credibility."

As noted in the last chapter, in the end, very complex issues will nearly always reduce to a political problem, even though, or because, they involve technical or scientific matters. Yet *once the policy parameters have been established*, there is overwhelming evidence (Chapter 3) that land information systems do contribute, though not in formulating or selecting the preferred policy. Like the policy analyst, it is unlikely that land information will be

> brought in until the policy level has the political aspects under control and there is general agreement on which of the various facets of the issue are the ones that will be debated publicly. It is only at this stage that attention is paid to the type of questions the analyst is most helpful in handling.
>
> [House & Schull 1988:198]

The apparently low level of influence of technical land information in the policy process should, therefore, not be unexpected by the land information systems community.

The last measure of utilisation intensity, that of non-referral, is, as suggested, probably more a matter of how the policy process operates, how the information is presented and by whom and the confidence they instil, rather than one of substance. As House and Schull [1988:163] point out, due to the complexity of most issues, decision making characteristically requires a fair degree of technical input, necessitating the use of fairly sophisticated technicians to prepare the technical analyses of the policy options. These analyses are done and refined at one staff level until the issues are considered "ready" for the next level where further discussion and analyses may take place. The process, interspersed with trade-offs, bargains and compromises (Chapter 6), continues between and among government agencies right up to the cabinet level for as long as resources, time, and patience permit. Even then, as Graham notes, when politicians have to make decisions on issues, they are often bombarded by masses of irrelevant information which buries the important facts in a deluge of paper [1987].

Unless, as in Niemann's [1987] land-use issue commented on earlier, particular analyses or submissions are managed throughout the policy formulation and selection processes, the chances of surviving – of being recognised or referred to – may be small. Only by accepting this milieu, by becoming part of the political process, can land information system practitioners hope to gain the credibility and status for their information systems in the public policy process that they feel are their due.

In the meantime, there is a range of additional factors bearing on the utilisation of information, over which the land information systems community have direct control. These factors include those relating to information presentation and communication, and the nature and credibility (in the eyes of the policy actors) of the information held and the values it represents. Modifying some of these aspects of land information systems in recognition of how policy is *actually* proposed, as distinct from the rational processes envisaged, may at least enhance acceptance of land information system results in the policy process. This possibility will be explored further in the next chapter.

INFORMATION IMPACT

Land information systems have the potential to influence decisions at different levels (e.g. routine, management, planning) for both important and not-so-important decisions. Important decisions according to Nagel [1988:20] are those that have a big net societal benefit in terms of cost. The application and utilisation of land information in predicting ("deciding") the flood pattern of the Murray-Darling river systems [Nanniga & Tane 1990] could be considered more important (because of their greater economic benefits to a greater number of people) than their use in a school's assessment management system [Meizis 1991]. Equally, importance, as it is in many policy processes, could be judged on the basis of some other criteria, such as equity, cultural integrity, environmental preservation and so on [Miller 1990:123]. The influence or impact that a land information system achieves on the basis of any of these criteria will depend, therefore, on the kinds of decision or policy process it affects. Any utilisation scheme, therefore, has to recognise that different kinds of utilisation could occur, depending on the importance or the level of the decision or policy.

For instance, knowledge acquired through interaction with a land information system about the permissive use attached to a residential land-use class may change a local government's policy position on permitting a light industrial development at a particular site. The same information system may also reinforce the local government's plans to develop its tourist facilities and small boat marinas. Reinforcing the tourist development decision probably confers a higher level of influence than converting the less important development decision, even though the degree of information utilisation of the latter is higher.

The evidence indicates that the influence of land information systems on decision and policy processes is much greater at the lower levels of the policy/decision making hierarchy. Operational and managerial decisions are not necessarily of lesser importance than those on policy and planning but, as policies are normally the framework within which they are constrained (Chapter 4), they tend to determine impact and influence. Thus, even though land information systems are being used extensively at the operational and planning levels, that is, their utilisation and contribution is high, their impact on the public policy process, for all the reasons mentioned previously, appears to be low. As Wellar [1990] notes,

> few non-trivial policy initiatives are presently derived from, supported, and sustained by a rational, robust, open, information-based process of deliberation.

While high utilisation *per se* may be of satisfaction to the land information system administrator, it is of much smaller consequence to the general community. As Glaser [1983:4] argues, such an attitude would be irresponsible as, ultimately, the meaningfulness of land information systems, as of all science, natural and social, rests in its ability and willingness to contribute to and maintain a responsible dialogue with the society that sustains it. If the land information system community wishes to have an impact in the policy domain, as it clearly wants to, then it has to adapt to the vagaries of this domain, not *vice versa*.

Conclusions

Despite the limitations and lack of definition of the utilisation measures adopted (perhaps equal to the lack of definition in the policy process), it is possible to draw a number of general conclusions about how information produced by land information systems is, and could be, used in the public policy process.

Given the nature of the public policy process affecting land, its judgemental mode of operation and its reliance on political means for resolving issues, it is perhaps not surprising that discernible instrumental use of any information, land information systems based or not, is low. This is not to say that when policy choices are technical, complex, or concerned with physical, as opposed to social process, high levels of expertise and instrumental information will not be needed. Policy issues of high technical complexity concerning land-based process will clearly increase the reliance on, and use of, land information systems in an instrumental fashion. But the incidents of these types of issue appear to be very much in the minority [e.g. Healy & Ascher 1990, Kraemer 1987, Zwart 1988 (Appendix C5)].

In the majority of cases, what is required in the policy process is information by which to gain insights and understanding about the issues, about possible actions and their likely consequences. It needs to be a *resource with which to bargain*, information that suggests and assists to develop possible solutions. This use of information in the policy process is at least as significant, if not more so, than the instrumental use which dominates the rational decision making processes of Chapter 5.

The discussion of the nature of policy decision making has assumed that decisions are observable; that you know one when you see one. In reality, as noted in the decision making continuum of Chapter 1, the matter is seldom so clear cut. As observed in the last chapter most policy choices are never made; they happen;

> countless approximate decisions are reached in many offices, each with a different brew of fermenting knowledge – and, of course, much else besides knowledge – until, like Moscow starting to burn, an hour comes and goes in which we later say, the matter was consummated.
>
> [Orlans 1973: 20, quoted in Weiss 1984]

Yet, amorphous as the policy process and the evidence of conceptual use of information may be, frameworks for action have to be in place when the need to respond to some event arises – it is the essence of the policy process. Directing land information systems towards providing conceptual information for understanding and clarifying land-based policy issues may be one of the few ways by which land information systems could live up to what is expected of them in the policy field: that is, to be of value and benefit through their use and influence.

The key to attaining such use and influence is to accept the public policy process as it actually is, not as some would like it to be. Such an acceptance includes, among other things, using land information systems to legitimise decisions made by other means. An ability to insert in the passion of a political debates, say, the results of a post-decision search of a land information system to serve as ammunition or justification for a controversial land management proposal, will probably be more influential, and have a greater impact, than attempting a comprehensive analysis that arrives too late or addresses the wrong question. Besides, if, as Annells [1987] suggests, land information systems are seen to be part of the solution, not as part of the problem, as technical advice often is, then its credibility will be enhanced, will begin to shape the language and future course of the debate. Having established credibility and a presence in less stressful or controversial times, they may then perhaps be called on in more conventional (rational) ways to actually be instrumental in the choice of action.

Establishing this initial credibility, however, will not be possible, irrespective of how the system is used, unless the data and information provided by the land information systems are accurate, timely and comprehensive according to the mores of the policy maker. For many tasks these will include contextual and historical information about, for instance, the previous land management decision, the issues that surrounded it, the values and behaviour pattern of the participants and so on. This is quite different to the kinds of data presently held in most land information systems or covered in present day standards. Again, if land information systems are to be seen as contributing to the public policy process then they must also be prepared to embrace and accommodate these different requirements within its structure.

What is being suggested is that, for land information systems to be used and to influence or make a difference in the policy process, they will need to extend their capabilities and data holdings to: facilitate conceptual use; incorporate inductive processes for linking decisions; and include contextual and value data statements in their data bases. Without additions of this kind they are likely to remain on the margins of policy debates concerning the use and planning of our land resource.

Yet, despite what may have been said in previous chapters, those responsible for making political decisions about the use and enjoyment of our land do at times wish for an assessment of various policy options, and, when they do, would prefer it well grounded rather than not. Secondly, even though such an analysis might in no way determine the final outcome of the political process, it may form and influence it. To the extent that facts and logic are brought to bear and are the currency of political debate, it is desirable that they should be accurate. But just strengthening the knowledge base of policy making, as many believe conventional land information systems would do, while important, is not a sufficient condition for improving policy. Each policy arena must make sense of good data and good ideas from all sources, including land information systems, in their *organisational and political context*. When the context obstructs access, better knowledge may not reach key policy actors. When the context discourages policy makers from taking the time, the energy, or the risk to discover and heed it, better knowledge is unlikely to inform policy directions. It is within these constraints that land information systems can attempt to improve their contribution to the public policy process. It is within this framework that the restructuring and modifications in the next chapter are proposed.

PART C

Policy Based Land Information Systems

CHAPTER 8

UTILISATION OF INFORMATION IN THE POLICY PROCESS - EMPIRICAL FINDINGS

> Our information may be important, it may even be crucial but it will not always be seen in that light by the decision maker.
>
> Graham 1987

Introduction

The review of the land information systems, policy and information utilisation literature in the preceding chapters was used to formulate a model of the interaction between the availability of scientific (land information) data and its use in the public policy process. In this chapter some empirical evidence gathered mainly from the chief government agency in Tasmania responsible for land management will be used to examine the efficacy of this model as a description of what occurs in practice. The aim is to validate, modify or refute the hypothesis that information provided by land information systems as currently conceived and implemented have little or no direct impact on the public policy process affecting land, that the value laden public policies on such matters as land use are political rather than technical issues ameliorated not by rational but by highly subjective processes in which technical information is but one, and then generally not the most decisive input.

The 'real' world evidence used for this validation will be the interviews[1] conducted with three individuals with responsibilities for land management in Tasmania plus the background information described in Chapter 1. The people interviewed were the Secretaries for Department of Lands, Parks and Wildlife (later the Department of Environment and Planning) Mr Bob

[1]The interviews with Annells and Graham were conducted by me as part of the 1987 Australian Urban and Regional Systems Association conference with the theme "Information for Policy Makers". The interview with Annells was written up by me, modified and presented by Annells at the conference. Graham used the interview material to write his own presentation. Both presentations were subsequently published in proceedings edited by me. The quotations in this chapter are from correspondence, the interviews and the presentations. The quotations from Ramsey are from the interview.

Annells [Annells 1987] and Mr John Ramsey [Ramsey 1994] as well as Mr Bob Graham, former Minister for the Environment and Planning [Graham 1987] and now a professional planner. The material gathered from these interviews is analysed on the basis of the main elements of the model but before examining these, the assumptions on which the model rests will need to be confirmed.

Operational Decision Making

In Chapter 3 the operational gains in the efficiency and effectiveness of decision making at the administrative and operational levels were examined. It was concluded that "for the purpose of this study, ... we will take the gains in operational efficiency and effectiveness as given." Is this assumption justified and can it be supported by empirical observations particularly in view of the dearth of formal post implementation studies of the real benefits of land information systems for this or any other purpose (Appendix C5)?

The resounding answer for the efficiency type problems (Chapter 1) has to be yes. Annells states there are gains "in terms of manpower and us doing the job faster and more accurately" ... and gives us "...a significant capacity to improve things". Ramsey, seven years later, comments he sees the strength of land information actually getting the information together in a useable form with one of its real benefits being "... able to see the whole picture ..." particularly "... in the environmental management planning area". Both suggest that the technical, professional advise they can give is more comprehensive, more accurate and more credible in political terms, in part due to a general assumption at this level that "... computing is good ... will produce the required information", a view which has "... been accepted I suppose at a senior bureaucrat level, and not really challenged at a ministerial level in any serious way" [Ramsey].

This believe extends in particular to land information systems where "... an integrated and centralised land information service (is taken to be) essential for the economic and social management of Tasmania." Improved management of the State's land information is seen as benefiting "... all sectors of the State's economy" and "... as a consequence, the management of this 'land information' should assume a high priority in all sectors of the government and the private sector." It will improve "... confidence in the reliability of the data which is critical when managing administrative information upon which investment decisions are made, such as ownership, rights of access and permitted use" [LIB 1993].

Apparently, the Tasmanian Government, and its senior advisers in the land administration area, like other governments in Australia and elsewhere, continue to accept land information systems as providing benefits in the form of improved management practices, greater access to information and as a result, improved decision making at the administrative and operational levels. While this acceptance may at times be too uncritical [Ramsey], the proposition, derived from the literature, that land information systems do assist positively in structured decision making can be upheld.

Formal Information in the Policy Process

GETTING INFORMATION INTO THE POLICY PROCESS

Before specifically discussing the role of formal information it may be useful to examine how information in general, is inserting into the policy setting process for resolving controversial, value-laden land use issues. Graham, who was the minister responsible for the controversial Franklin Dam project says that information typically arrived on his desk from his own department, competing departments, the media, backbenchers, lobby groups and political staff. The advise he received from his department was "... most likely to be a summary of many documents prepared by many people. It represented an interpretation of both data and the political and public service realities." While this the information is assumed to be accurate and value free he remarks that "neither is always the case."

Hence "the information delivered to the Minister has been through a filtering process, which will mean that not all matters are documented, that there will be bias, and it will be selective." The question facing the land information systems community then is how to ensure that its data firstly survives in this process, and that if it does, how to minimise its distortion through contextual and interpretive changes. Otherwise, as Graham concludes, in this situation the type of information with which we as professionals are familiar becomes lost in the mass of other information "noise".

PUTTING INFORMATION INTO A POLICY CONTEXT

One of the main conclusions reached from the literature on the policy process is that if land information systems are to rise above this "noise", are to be of any consequence in policy setting, then firstly the information has to be placed in a context and terminology which is understandable to policy advisers and politicians, and secondly, that the range and type of information these systems contain needs to be expanded. Annells in particular is fairly forth right on these points.

Firstly, referring to the need to package his advise, Annells observes that getting it to Cabinet requires his advise to be expressed in such a way that " it's language, values and perspectives reflect to the extent possible those of the ministers dealing with the issue ..." not his personal values or those generally espoused by professionals.

> "Information at this level has to be directed towards a certain result at a certain time and at a certain place, and presented in such a manner that it cannot be avoided or used to divert to some other course of action."

In other words, from Annells point of view as a policy adviser, the information he presents has to be highly focussed towards achieving a specific objective with the process of presenting the information managed to this end. To do this does not require "too much information of the type that is generated through information system" but rather a "knowledge of where particular individuals of influence stand on the particular issue, who is supporting who, ... where do the public stand."

If the presentation of professional advise is not managed along these lines, it may be swamped, may become just another piece of information out of many. Extending the capabilities of land information systems through alternative data structures and additional functionality to assist in this information 'transformation' and presentation task can therefore only enhance its utility in the policy process. Ramsey when asked whether such an extended capability would be of value, or even possible given the volatile nature of the land management issues he was dealing with replied

> "I think we would need to sit down and work out what our critical decisions are, and deliver the information in those particular ways. But we might have to deliver the information in a heap of different ways and it would be a matter of priority, but you could work out what is the critical use, what is the best purpose ..."

He went on to say that he would expect his officers working in this area to have such a capability when their basic land information system was sufficiently advanced.

Secondly, Annells states that the advise he offers has to take "into account a broad spectrum of views on land use and property related matters"-not just the comparatively narrow scientific perspective on which information in land information systems are typically based. After noting that land related issues are and will remain "highly politically sensitive issues" he goes on to say that

> "to be an effective adviser in this field requires not only detailed [factual knowledge but also knowledge of what issues are of concern and what standpoints are being adopted. It is only when you are really on top of it personally and you have managers on top of it as well, that you can hope to manage the situation in any sort of professional or long term sense."

In other words, if land information systems wish to be "on top of it" too they need to adapt to include information and processes which are significant in refining issues, help to identify stake holders and their positions and provide information on the history and the context of the issue.

The Policy Process

SUBJECTIVE FACTORS

The interviews also confirm the essential subjective and judgemental nature of the public policy process.

Annells as the senior policy adviser and Graham as the responsible Minister note the informal subjective nature of their main information sources. They both commented on the reliance they place on "trusted advisers" [Graham] or on people "... whose advise you can trust." [Annells]. Interestingly, while Annells recognises the need for factual information, he is more concerned about "... a critical shortage of people whose subjective advise is sound, whose information is consistently reliable and where political sensitivity is well developed." Even when technical advise or information is sought, political or other subjective factors will influence how this technical information is interpreted and applied in the decision process [Graham].

All three interviewees lament the impossibility of making balanced and informed decisions on the basis of knowledge and information received, of what ever kind, due to the absolute shortage of time. As Graham observes about the Cabinet process "... Ministers will only have about 10 minutes at most to put the case for the project and to sell his or her colleagues on the project." To do this 'selling' the advise Annells gives has to be capable of capturing the imagination of very busy people, "... who often have instinctive feelings about an issue or have strong personal views or may have already made up their minds."

Hence when advising his Minister he has to 'repackage' the information coming to him to re-enforce or neutralise, which ever is the case, these biased positions and values. The observations in earlier chapters on the subjective nature of the decision making process in the public policy arena seem to be well founded. As Graham noted more or less as a parting shot "a politician does not win votes by reading reports, analysing statistics and thinking deeply about an issue. There are too many competing demands for his precious time."

BARGAINING

As the above discussion implies the process of formulating and getting advise (information) into the policy decision making process involves extensive bargaining, at the ministerial and policy adviser levels e.g. "all agencies who are likely to have an interest in the matter have to be consulted" or more directly (Annells explaining his interaction with his counter parts in other Agencies) "... I have carefully addressed this as one of my options and explained why it won't work. I am sending you a copy of that segment (of my Cabinet submission), how about we talk about it and you talk to your boss and see if you can get him to understand that it doesn't work like that ..."

Graham at the Cabinet level suggests that the chances of selling his or her colleagues on the project is made easier "if sufficient lobbying of colleagues has been done."

INFLUENCE OF TECHNICAL INFORMATION

Neither Annells, Ramsey nor Graham when asked could site an issue in which some piece of technical information has either converted or influenced a policy outcome in a value laden situation. All could quote instances of management or operational decisions within a policy framework surrounding a controversial issue which were made through the injection of technical information or processes but when it comes to establishing that policy framework Ramsey notes that "... in the value judgements area the people factor is always going to be absolutely critical." He goes on to say that he would find it very difficult to "... believe that the minister is going to say I've made this judgement because we've done some modelling and the computer outcome is this." Yet at the same time, the Minister and Cabinet were happy to endorse the report "Land Information – Managing a Vital Resource – A Strategic Directions Paper [LIB 1993]" commissioned by Ramsey which,, amongst other things, states

> The data needs for the development of state planning policies and state of the environment reporting will be extensive and cross-sectoral whether in developing policy or in evaluating the benefits and gains from policy. The task of analysis and presentation in informing decisions will require a comprehensive supporting land information resource.

Re-enforcement for Ramsey's view is given by Graham when he observes value laden decisions will always be influenced by the political environment "... and with the best information in the world this will not change."

This is not to suggest that technical information is not used. As Ramsey says in most cases where the Minister has a policy outcome "if the computer modelling supported it, he would say it was wonderful modelling and it would support the decision, but I do not think he would make the decision on the basis of the model results." That is, the information may be used to reinforce a decision already made on other grounds. It is most unlikely that the technical information will have been used instrumentally in reaching that decision.

This mode of using technical information does not, and as Annells insists must not preclude the advise he offers from being factually accurate, reliable and professional if for no other reason then as an insurance policy- "... the one factor that will destroy credibility faster than anything else is if an opponent arrives on the scene and manages to produce some piece of pertinent information that you should known, and clearly did not."

Ramsey takes a slightly less cynical view. When asked what role he saw for hard core scientific data in the policy process he stated that

> "... our advice to the minister would be that he *must* accept that information ... this is the science, this is the data that has been collected. You can't argue with the data. You could make some judgements about what you want to do with it in the next phase, but these are the facts, this is what's been established."

The real question then becomes not the validity of the supplied information but rather how it is used in determining policy-what to do with it -for as noted in Chapter 1 the information in itself normally cannot determine what to do, which course of action to adopt. This largely remains an article of faith which escapes rigorous quantification.

The fundamental issue then becomes according to Ramsey, the weight assigned to the technical information in formulating the policy responses "and the weighting is a value judgement in itself", which "has got to be made by the decision makers, not the people who construct the model."

These comments support the conclusions reached in the preceding chapters, namely, that the evidence for instrumental use of formal information and modelling techniques in the policy process is scarce indeed. Even where it is used it is unlikely to be accorded any special weight in setting policy directions when the issue is surrounded by multiple stake holders, conflicting solutions, values and beliefs. That factual information is included in the policy process is not in doubt, advisers like Annells and Ramsey generally ensure that this type of information is presented when appropriate. What is in doubt is its effectiveness and the importance assigned to it.

USE OF INFORMATION TO LEGITIMISE OUTCOMES

Using factual information to support an decision or policy position derived by other means occurs in a number of different ways.

Given that neither Annells or any of the others could recall an issue in which technical information was an influential input, he was asked, where planning information fitted into the policy process, does it or is their a symbolic element.

> "I believe it's more symbolic than real. I think that people and government will back planning as an exercise, as a process, for as long as there is no controversy about the result, or the controversy is seen as being manageable."

Annells goes on to say that since most planning issues are controversial and surrounded by a range of values and believes the use of information will be equally subjective and biased towards one particular point of view or outcome. He therefore argues that providing technical and professional advice to support a predetermined decision is a common occurrence,

> "and in my view a legitimate use of professional advice and information by Government. The text book model of having prior information to use as a sound basis to plan and choose options is in my experience not always the norm."

Ramsey is not prepared to go as far as Annells in using technical information to legitimise a *decision*. He would however use it to support a *formulated position*. "I would be thinking, this is the way to go, and then I might ask, is there anything to support this formulation." Unlike Annells, however, he does not believe "there is a lot of legitimisation going on, yet may be there should be" but even then "... the pressure of business is such that I don't know that we could do any structured research to support it."

Graham confirms what the literature review revealed, namely that the cult of the rational is alive and well in the political world.

> "Most Ministers will place significance on technical and professional information, particularly statistical information, but frequently as a justification for the decision, which more often then not is a "political" one rather than one that to us appears rational. That does not make the political decision wrong-it just makes it appear wrong in our eyes.
>
> There is always the tendency to use statistical and technical information selectively to support political positions."

As observed in earlier chapters, value laden issues, with very few exceptions, will always be decided on political (Ramsey's people) grounds even where the issue is essentially a technical one. Such decisions, as the discussion has highlighted, will almost certainly involve, in one form or another an element of legitimisation. Given that this is the reality of the policy process it would seem churlish for the land information community not to modify its systems to accommodate this process because it perhaps challenges the rational believes on which these systems rest.

The Policy – Information Model – and summary

The observation and experience of the three people interviewed and my own background experience with land information systems lend credence to the interaction between formal information and the public policy process concerning land use management derived from the literature in the earlier chapters. While these empirical observations due not cover every element of the model, they do lend support for its conclusions and its overall thrust, namely, that land information systems as presently conceived do not make any special contribution to the policy process affecting land and that unless they adapt to the reality of this process they are unlikely to do so in the future.

The data has confirmed that complete, up to date and comprehensive scientifically verified information in most cases is "... a luxury that you probably can't afford and don't really need at this level" [Annells]. This is not say that the information is not put forward, it is. As Ramsey comments, if the information has been collected through our system, "we would expect to have a degree of integrity that is better than a letter from a constituent or the council or whoever. I would be saying to my minister, you know this is what you base your decision on minister."

Yet, as all the evidence suggests that in the subjective world of policy making it will not be used for modelling or formal analysis. It will probably only be used by ministers who "... operate as part of a management team responsible for an enormous range of decisions most of which he or she has only the vaguest notion of what is involved." [Graham] – and then only if it supports the political imperative.

Public policy setting is a subjective, biased and value ridden process, which as Ramsey says we have to accept for what it is a process dominated by irrational, normal people.

> "The difficulty in all decision making is the people factor, where people come from, and no computer is going to help you with that because they'll have a different view by tomorrow morning."

At the same time as Annells notes, for the average bureaucrat and politician the concept of land information systems, and what they can provide, "is a very difficult concept to grasp." It is therefore of critical importance that if we do wish to have land information systems play a more significant role in land based policy formulation that these systems become understandable and meaningful to senior policy advisers and politicians *in their terms and in their context*.

> "... the bottom line is that if you are going to have any influence on what happens you must first be seen by the people who seek your advice to be credible, that is, credible in their eyes, and by their values." [Annells]

It is also essential in Annell's opinion that the people who do have the skills and knowledge in land information systems "... apply as much effort in educating people about them, as they do to further refining them." This is particularly so as Ramsey foresees the day "... when we are in the minister's office and we could call up something on the screen and illustrate the point." It is only at that stage that Ramsey sees any possibility of land information systems being more than "of high persuasive power" and begin to help in making decisions.

Equally important in Annells view is that the land information fraternity gains an understanding and appreciation of the role that policy advisers like him play in the policy process. By acquiring such an appreciation it may assist land information practitioners "... to become more effective in the advice they in turn give, in the way information is presented to persons in similar positions to mine, and thereby improve the efficiency and acceptability of information systems in the wider Government context." Hopefully, as stated in Chapter 1, this thesis, and its recommendations for a policy oriented land information system which follow, will aid in this educative process.

> "... So, can we have an information system for politicians. My view is that such a system would be impossible to develop, let alone implement. What perhaps we can do is to understand better the needs of the politician and the realities of the decision making environment in which they operate. We, as professionals who provide and prepare information for politicians, whether directly or indirectly need to be aware of the fact that our input is only one of many into the process.
>
> The easy part is to produce information. The hard part is to make sure that it is interpreted, understood and used correctly."
>
> [Graham]

As presently constituted land information systems successfully produce the easy part but, as demonstrated above, fall short on the second. How some of this shortfall might be made up is the topic of the next chapter.

CHAPTER 9

SOME CHARACTERISTICS OF POLICY-ORIENTED LAND INFORMATION SYSTEMS

> Since science is the central symbolic structure of modern industrialised society, the invocation of science to solve a problem has a political power of its own.
>
> William Clark

Introduction

The preceding chapters identified a number of attributes which a land information system should possess to improve its chances of being used, and influencing or otherwise contributing to the policy process. In summary these are:

- The decision maker not the land information systems should direct the use of information in the policy making process.
- The land information systems should facilitate the judgemental, bargaining and reasoning processes.
- Modelling and analysis activities plus their results need to be direct, simple and clear.
- The system should be directed towards learning about, and acquiring an understanding of, rather than deciding about, a particular land management or planning policy issue in its context and from the perspective of the policy actors.
- The information obtained from the system must be reliable and credible by the norms and standards of the policy maker.
- The system should have functions that permit inductive as well as deductive operations on its data.

As indicated in Chapter 2, and Appendices C1 and C4, present day land information systems do not have, and are not directed towards performing, the above functions.

Taking the above list as "user specifications" for a policy supporting land information systems, this chapter will propose some conceptual ideas on how these requirements may be realised, and it will contrast them with the properties of existing land information systems as outlined in Chapter 2. It will build on the fundamental strength of land information systems as a foundation on which to integrate, and make compatible, physical and cultural information. The resulting design parameters for a policy supporting land information systems will, it is hoped, assist in implementing data constructs and system features that will have an ability to:

1. Help decision makers to identify the substantive policy issues surrounding a particular land management or planning debate.

2. Readily provide information to assist in defining the social and political context of the debate.

3. Support the identification, evaluation, and comparison of alternative policies and implementation strategies to resolve the issue at hand.

A system with these features should be viewed as an addition to, or an extension of, present day land information systems, not as a replacement or substitute (Figure 9.1). Existing systems will need to supply much of the basic information about the land and its attributes, and provide some of the manipulation, extraction and presentation facilities of Figure 2.1. The policy system would restructure the data it receives from the "ordinary" land information system, have links to other policy-relevant information sources and have additional manipulation, analysis and presentation tools. How the data within in the system is organised and the functions which it performs, however, may be quite different to those of current land information systems.

A policy-oriented land information system should be viewed as supporting the policy process for land based and land related policy decisions only; it is not intended as a system to support public policy issues and objectives in general. As land matters are pervasive, the scope of such a system, and the issues to which it could lend support will still be broad, yet its focus, by the nature of its land based data and functionality, will be narrow. The policy-oriented land information systems being proposed will not take a mind-reading miracle, and a budget of bottomless proportions, to develop and maintain a staff-driven, information resource/IT capability that could effectively and efficiently anticipate and respond right now to whatever matters might come down the pipe.

[Wellar 1990]

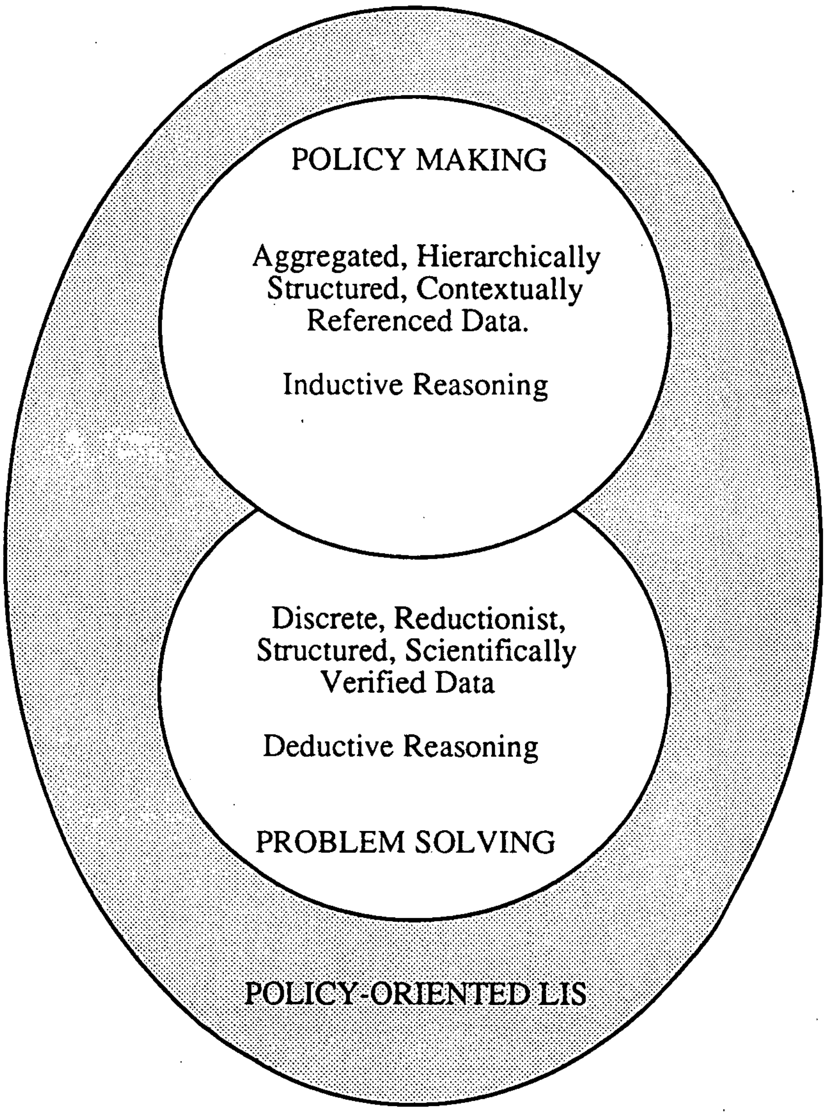


Figure 9.1 Policy-Oriented Land Information System.

The system's aims will be much more modest and in keeping with systems like the National Science Foundation's Policy Information System, which confines itself to using science and engineering statistics data bases to monitor performance and gain an understanding of America's science institutions [Knauth 1990]. In our case the system will be confined to land related policy, through accessing an inventory of spatial and related aspatial data.

Background Considerations

Policy-oriented land information systems need to operate in a different context, and contain additional and differently organised data, on which different searching and analytical functions operate.

Outlined in this section are a number of background factors that set the broad parameters for a policy-oriented land information system. They recognise the shortcomings of existing land information systems for this task, and point to the capability and data structures that such a system should possess.

They also place these policy-oriented land information systems firmly in the policy rather than in the scientific domain, in Mintzberg et al.'s [1976] model rather than the prescriptions of Chapter 5. It will be the requirements of the policy process that determine the specifications of these systems, not the technology or the form and function of existing land information systems designed for ordinary decision making tasks. In this sense, they parallel the notion of embodied GIS proposed in Appendix C6, wherein the operation and functionality of a land information system is subjugated to, and contained within, more general systems that focus on meeting the *specific* and *dedicated* needs of groups of *specialised* users. In this instance these users are the policy analysts, chief executives and their political masters, who advise on and ultimately determine policies affecting land. They will use the system to respond to policy issues, investigate relationships and analyse policy objectives. The information system has therefore to be placed in their context(s), maintain data in a form, and to the standards of performance and presentation, that satisfy their environment, their realities. Hence, to paraphrase House and Schull [1988:160], whereas problem-solving based land information systems are directed towards discovering absolute truths, with the exactitude of near certainty, policy-oriented systems need the ability to be able to provide best available information on time, when the decision must be made. Where one operates in a scientific context, the other needs to be put into context that the policy maker will find most useful.

CONTEXTUAL CONCERNS

Policy-oriented land information systems need to acknowledge and work within the perspective of policy actors

"One cannot understand without the context" [Rittel & Webber 1974]. We cannot have a policy-oriented land information system without including information on its context, either as a variable, as a function or embedded in the organisation of the system.

The scientific or rational context (perspective) is the foundation of our current land information systems. It is *one* way of viewing the world. There are, however, many others, and many ways of looking at perspectives [see Linstone 1984:25 for a literature review]. One organisational based view on perspectives is shown in Table 9.1. This table characterises some selected perspectives of three groups: the land information systems practitioners, the professional policy analysts, and the politicians. Each of these stylised groups has a legitimate perspective on how the world does (or at least ought to) operate. Land information system practitioners may approach a policy issue as a challenge to their skills, an opportunity to apply their technology. The analyst and the politician perspectives will probably see the issue in terms of efficiency or advocacy as per Mintzberg et al. [1976].

Each of these perspectives is clearly legitimate, and each group has developed more or less formal techniques and rules for dealing with the world and its issues from their perspective. Each has its own logic, its own jargon, and its own goals. Although it is unlikely that those in one group would agree with the form of logic and techniques used by the other, there is a need to at least recognise that the techniques are proper for *their* purposes.

Land managers, policy advisers and analysts are given questions that *must* be answered, and specialise in formulating these questions into issues that can be analysed using *existing* data and information. Unlike scientists or land information system practitioners, the analyst does not expect to be in control of his analysis, from data to technique, nor does he form hypotheses which are to be "tested" for correctness. The analyst's job is to provide the best response to an issue, given the available time and resources. The process they use, and the place of information takes, are

Table 9.1
Perspectives on the Policy Process
[Based on Nagel 1980 and Webber 1983]

Type of Policy Actor	Public Policy Problem	Motivation	Model (World View)	Approach	Symbolic Generalisation	Relevant Training
Land Information System Practitioner	Formulation and Implementation	Informed, rational processes	Rational	Objective	Factual, optimum	Information management, spatial representation and analysis
Professional Policy Analyst	Design	Improvement of policy and policy making	Mechanistic contextual	Utilisation of knowledge	Consensus, public opinion	Decision analysis, benefit-cost, modelling
Politician	Value maximisation	Advocacy of policy position	Form contextual	Rhetoric	the people, national interest	Gathering "useful" evidence, effective presentation

therefore, much closer to Mintzberg et al.'s [1976] and Annells' [1987] observations than to the rationalist/homo-economicus models favoured by the land information system community (Appendix A5).

The goal of the analyst is not "truth" *per se*, but a "good" analysis. The approach used in assessment is to define the problem in terms of its solution. In doing so, the alternatives for resolving the issues are studied, and where possible the quantification of the issues' elements may be attempted. It is at this stage that the data and information initially obtained from a land information system might be of use in the analysis.

To some extent the analyses always address only a portion of the questions, and that portion is decided by available information and the situation in which an analysis is being done. Hence:

> In short, since it is presently impossible for each analyst to consider the effect of a perturbation of every conceivable variable on every other conceivable variable, there has to be a selection of what is important enough to be studied by the analyst and presented to the decision maker.
> [House & Schull 1988:160]

The process is therefore not a search for basic knowledge; rather it is a search for alternative responses to questions embedded in the context of the current situation or "bushfire". Policy analysis, consequently, is often more an art than a science, in which the possible is separated from the improbable as speedily as possible.

From this, and from the discussion in previous chapters, it is clear that the two groups, the policy actors and the land information system practitioners, need to respond to their respective agendas, and do so from a different perspective. Given these differences, there is no reason to suppose that the information being developed in the land information system area is available to or is understood by those in the policy field. At the same time, there is also no reason to suppose that the land information system proponents would necessarily understand what information, or even what *form* of information, is required by the policy actors. It is not until they do obtain such an understanding, not until they place their system in this perspective, that their information is likely to be referred to, let alone allowed to influence a policy outcome. As Knauth [1990] observes "executives in both government and the private sector depend on data analysts to organise data into a usable form, to put in context." Policy-oriented land information explicitly acknowledge the contextual and data needs of the policy process.

Policy-oriented land information systems will be required to support historical, present and predictive contextual operations

As noted in Chapter 6, public issues concerning land are subject to a wide range of interpretations, from a wide range of interests proposing equally wide ranges of remedies or actions. Accordingly, the perspectives from which an issue may be viewed, their intensity, scope and complexity, may also be numerous. Part of the analyst's task is to incorporate and suggest policy outcomes which reconcile these perspectives.

Yet, at the same time, "real world" constraints of time and resources, or legislative, judicial or administrative prescriptions, will limit the amount of policy analysis that might be performed. Further constraints are introduced by the nature of the topic, that is land and its use, and by what is possible or meaningful to represent in computer format. Hence, the number of contexts, or points of view, which can be examined will usually also be limited and selective. For some policy questions, quantitative policy analysis in any form may be altogether inappropriate.

In this situation, the analyst must attempt to integrate the perspectives and, since it is likely that the results will have to be presented to different policy makers with different backgrounds, training and interest, the information may need to be repackaged in several different ways to clearly present the results in a language and from a perspective that is meaningful to each of the decision makers as well as any affected interest groups. Successfully repackaging and presenting the results in a way which is understandable to a broad spectrum of decision makers and interest groups is difficult, but graphical communications can play a significant role.

Irrespective of the number of contexts that may have to be considered for any one policy concern, there needs to be an ability to view the issue from several points of view by switching between contexts. This means that in the functional domain a policy-oriented land information system has to be able to place information, or transfer it, into any of three broad contexts.

- Historical perspective – the source of the issue, events leading up to the issue, past states and conditions; "facts" in the historical context; average over the last ten-year period; rate of change, rate of growth.

- Present context – comparison with similar states in other geographies, jurisdictions, economies.

  Contributing factors; linkages and associations with other factors, issues and policies; related information.

- Predictive context – short term probability forecasts, long term evolution (over ten–twenty years); policy alternatives and their impact, impacts on other policy outcomes; groups and agencies affected.

Thus, for example, policy-oriented land information systems assisting in a land use dispute over the rezoning of an environmentally sensitive area would need to be able to provide information (either directly, or as a result of some analysis and modelling) on the source of the conflict, e.g. competing land use claims, their origin and bases; existing land use; information on comparable land use situations in related areas; their outcomes in relation to other land use policies; impacts of alternative land use scenarios; possible trade-offs and their consequences on interested parties, e.g. land-owners, recreational users, economic activities.

Policy-oriented land information systems should be designed to support, political, social, economic and environmental contexts

The "functional" contextual changes called for above will have to overlay the conflicting value and interests held by various parties involved in any land management issues. Land use and land allocation decisions, as noted earlier, are essentially the activity of assigning and redistributing wealth and usually also some associated power. There are no quantitative rules that adequately describe how trade-offs are to be made between the physical, social, and economic considerations for such policy decisions. Items such as cultural habits, social choices, institutional relationships and politics are not conducive to analysis. They are, however, conducive to information presented in terms and in a context that is meaningful to policy actors, which supports their case or reduces the advantage held by opposing views.

Hence, as Annells observed in the last chapter, planning decisions, particularly about land use, tend to be controversial, encompass a range of values, and are viewed from a host of perspectives. Positive steps have to be taken to repackage the information to accommodate these views, personal biases and beliefs, and the process of getting this information to the right policy actors managed.

Policy-oriented land information systems will therefore hold information in a number of contexts. Present day land information systems collect information from a scientific perspective, that is, only information which conforms to some predefined yardstick to ensure consistency and objectivity. There are, however, other ways of encoding problems and gathering data. For example, if we encode geological data from an economic perspective, e.g. hold information on its economic value given certain mining techniques and market conditions, this is different to its aesthetic context, e.g. its scenic or cultural value, and different again to its structural or engineering value, e.g. its load-bearing capacity, its resistance to wear. Similarly, as Raup [1980:23] notes, such a

> divergence in perspectives has in the past confined the Department of Agriculture to focus on commercial agriculture, the Forest Service to focus on timber production, and the Department of Interior to a preoccupation with mineral lands.

In a policy-oriented land information system, each of these data types will be held, their context noted or derived, their relationship to the other contexts recorded, and means for linking data across contexts provided.

At least conceptually, and depending on the way contextual information is implemented perhaps also physically, the notion of data independence, that is, the separation of data from its function (discussed in Chapter 2), may need to be modified or abandoned. This is already being attempted in some land information systems, as will be briefly discussed later in this chapter.

Policy-oriented land information systems will need to provide assistance in transforming and integrating differing perspectives

Each of the groups in Table 8.1 constitutes a separate "culture" whose members are linked by common habits, assumptions, attitudes, behaviour patterns and beliefs. While these are mutually reinforcing to its members and reached by individuals without thought, they rarely are aligned with, and are more commonly alien to, other groups with alternative world views and knowledge systems.

Such cultures, as Portner and Niemann [1984] report, are also found within the land information systems community, where underlying disparate values and beliefs of professional groups may need to be reconciled before common goals and methods for addressing overriding land information management and system problems can be formulated. As noted in Chapter 2, these values and contextual issues are of some concern to the formation of land information networks, but, through efforts like those of the Australian Land Information Council, they do not seem to be insurmountable, as the "cultural" separation between the land based professions involved is not great.

There is less room for optimism, however, when it comes to reconciling or integrating the views, *modi operandi*, beliefs and hence the knowledge of groups like those in Table 8.1 or general interest groups in the wider community. Webber [1983], in a review of "disciplinary matrices", reports on studies conducted by Kuhn and Lakatos. Webber suggests that even when the disciplinary matrices identify the points of contact, they do not necessarily lead to better communication between the disciplines involved:

> the opportunity for inter-disciplinary-matrix communication and exchange within the policy making process does not, of course, suggest that meaningful communication of ideas will take place, nor that information provided by the other community will be considered.

Calls like those by Portner and Niemann to measure and summarise the belief systems of professional groups involved with improving the land management process to lay "the ground work for more knowledgable and more productive interaction between groups" may therefore have limited utility.

Webber, Kuhn and Lakatos go further, and have pessimistic expectations about inter-community communication among scientists, and between scientists and the policy making process. They suggest that the prospects "are not bright", but as long as proposals for modifying the discipline's culture are presented in terms of *that community's matrix*, in their context and language, then there is room for more optimism. It is for this reason that land information systems will need to undergo a contextual, functional and "cultural" transformation if they are to become relied on, and are to have some influence in the policy process. A fundamental disciplinary matrix modification must be considered by the land information systems community, not by the policy making community. Proposals to use land information systems for legitimisation, as discussed in the previous chapter, even though they may be anathema to land information systems practitioners' view of the world, will permit and facilitate operations of this kind. In turn they may help to build bridges between the world of the policy maker and the world of land information systems community.

Policy making is essentially about bringing together and reconciling disparate values and beliefs in order to find ways and means of removing contentious issues from the public agenda. The land (geographic) information systems are about integrating and reconciling information be it in the physical, social or economic domains, through the one element that is common to all, location in space. There are presently no better formal means of linking, analysing, and visualising these disparate data types as some sort of holistic entity. As Linstone [1984:69] observes, any perspective will nearly always illuminate or add important insights to the other. Furthermore, individuals, organisations and professions change perspectives over time, settings change, and key actors enter and leave the stage. Because much policy making may extend over protracted periods (Chapter 6), policy-oriented land information systems should have the ability to at least accommodate these changes in context and perspective, and assist through the information it provides in linking and integrating these different points of view.

The literature on knowledge utilisation and diffusion indicates that such a task may be difficult, if not impossible. Yet, organising and labelling data in its context, and providing means by which to manipulate and communicate this data in ways that are meaningful to more than one culture, may help to break down some of the barriers. There is some evidence that this is already being achieved, through using land information systems as a clarification and mediation tool *during and as part of the policy process*, in a manner not dissimilar to the policy learning model of Sabatier [1987] (Chapter 6) [e.g. Simpson 1987, Niemann 1987]. Policy-oriented land information systems make operations and processes of this kind their focal point, a major feature of the system.

DATA CONCERNS

Policy-based land information systems aim to provide credible defensible data in a policy context

As the discussion in Chapter 6 noted, policy is essentially about reconciling interest-groups to accept policy outcomes which may differ to a greater or lesser extent from their own preferred position through a process of bargaining where knowledge is the medium of exchange and where each party gives up as little as possible of their position. To Annells [1987], writing as a policy adviser, information is also needed

> as an insurance policy to make sure that your advice, rather than the advice from the ten other sources often utilised by government, is accepted or, at least carefully considered. You have to be sure that you are not caught without a piece of information that you should have known and did not. If government backs you, accepts your advice and takes the hard political decisions, the one factor that will destroy credibility faster than anything else is if an opponent arrives on the scene and manages to produce some piece of pertinent information that you should have known, and clearly did not.

To be credible it is not sufficient to have information which is reliable and up to date in the scientific sense, although, as Annells observes, this is something "you omit at your peril". It also means being credible in the eyes of the policy actors and the policy decision-makers. What tends to count for them is whether the arguments they can advance are believable, whether the information bestows political advantage – can be carried with authority [Lansbergen & Bozeman 1987].

Just as there are substantial differences in process between the programmed problem solving and problem solving at the strategic level, so are there substantial differences in the characteristics of the information used to support each process (Refer to Table 1, Appendix C2). Policy-oriented land information systems will need to acknowledge these differences by incorporating them through modified formats, data structures and data items. The modifications and extensions include:

- Non-statistically based measures of risk to express the uncertainty and quality of scientific information in a policy context. Standard probability distributions and averages tend to mask individual events and discontinuities, and hence, the risk or effects of failure making them unreliable as measures of risk decision making [Linstone 1984].

These statistical outliers normally ignored by land information systems data standards (i.e. greater than two standard deviations from the mean) are exactly what may be required to determine the political risk associated with a particular policy option [Harris & Batty 1992:30]. Policy-based land information systems need to contain quality measures for data and analyses which are understandable in the policy domain.

> The need is not to remove uncertainty (for that is impossible) but to make it open and positive, rather than covert and manipulative.
>
> [Ravetz 1990]

- Assigning values or categories to data of this kind may change or hide some of their original purpose and meaning, and engender a higher level of confidence than is perhaps justified. As Funtowica and Ravetz [1990:125] point out, in prose form "a million" may function as a unit for a generalised large quantity, whereas 1,000,000 or 10^6 presupposes that it means precisely one million. Numerically representing for example social values may therefore place them in a different context with a different intent and purpose to the one originally intended. Non-numeric means for representing and manipulating information on subjective values will need to be incorporated into policy-based land information systems if they are to ensure credibility.

- Many land use science related issues, such as soil salinity, vegetation die-back or pesticide use, are not chosen for study because of their intrinsic scientific interest but are placed on the public agenda because of the practical urgency of finding remedies, taking "scant heed of the feasibility of the solutions they demand" [Ravetz 1987]. It has been taken for granted that science provides solutions, provides the "hard facts" in numerical form, in contrast to the "soft", interest-driven, value-laden determinants of politics. But, in recent years it has become increasingly obvious that now, policy makers more and more need to make "hard" decisions, choosing between conflicting opinions, using scientific information that is irremediably "soft". As a consequence,

> we now see an inversion of the old distinction between hard facts and soft values. We face decisions that are hard in every way, where the scientific inputs are irredeemably soft.
>
> [Ravetz 1990]

Yet policy makers still tend to expect straightforward information as input to their decision making process; they want their numbers to provide certainty. To illustrate the point, guidelines for New Zealand's Resource Management Act 1991, while acknowledging that "there will always be subjective scientific interpretation" of information, goes on to state, "what is important is acknowledgement that the methods used to generate information and impact predictions are scientifically sound" [Ministry for the Environment 1992:18].

This simply may not be possible or a politically defensible option. The technical issues concerning the environment and land management typically involve such scientific uncertainty coupled to inescapably social and ethical aspects – a combination that is all but guaranteed to generate controversy and division [e.g. Healy & Ascher 1990, Smith 1990, Chapter 6].

It will be of prime importance for establishing the credibility of land information systems as a resource in the public policy process, that the scientific uncertainty associated with much data be explicitly acknowledged in the system and properly presented to policy makers *in their terms* so that they are forced to recognise the inherent limitations of the information they are being offered and acknowledge these in their proposed policies. Land information systems cannot, as often happens in many scientific investigations bent on objectivity, and as Chapman [1990] observes, just provide the information and leave the policy makers "to make whatever sense they can of it."

Policy-oriented land information systems to be effective will need to be in-house or on-line

There is evidence to suggest that should information conform to certain criteria, then the probability of its being at least referred to in the public policy process (Chapter 7) is greatly enhanced [Fellar et al. 1979, Quadrel & Rich 1989, Knauth 1990]. A criterion of central importance is having the information resource accepted as part of the standard procedures used by government and policy units to cover the range of circumstances that must typically be managed in a particular policy process. Applied to the issue of information selection, these standard procedures reduce uncertainty by categorising decision situations and laying down routines to select choices for each type of policy decision. According to Quadrel and Rich [1989] studies have shown that information selection procedures reflect the importance of assured, timely access and predictable outcomes of information searches. Amongst the criteria used to decide where information will be obtained are the following:

- Structural proximity. If the information is available from within the organisation it would be preferred to outside sources.

- Temporal proximity. Having information immediately available as response to current crises in a form policy makers desire is important to a source's acceptance. As a result, as Peter House, the director of the NSF Policy Research and Analysis Division notes, "we are encouraged to get as much data as we can in house, and under our own thumb" [Knauth 1990]. Where sources of this kind are perceived to be inadequate, law-makers, as Fellar et al. [1979] note, "disproportionately seek information directly from external sources by-passing advisory staff."

- Information sharing norms. Information is more likely to be asked for from sources with which there is an established precedent for sharing information than new or unfamiliar sources.

- Usability. If the information is in a form and style which is easily understood and applied by the decision-maker, then the information is more likely to be acceptable and its value appreciated [Quadrel & Rich 1989].

The design of a policy-based land information system needs to be sensitive to all of these criteria. The advances in the technology of land information systems (Chapter 2), the land information data networks which are being established in Australia and other countries, plus the adoption of the contextual, learning and data considerations outlined in this chapter, together suggest that policy-based land information systems for land management policy which contain these information selection criteria, could be realised.

Policy-oriented land information should support simple spatial modelling functions

As noted in Chapter 6, the results of policy analysis and modelling activities tend to carry little weight in the policy evaluation process since multifaceted issues, despite their intellectual challenge, are least likely to be clearly enough defined to be empirically dimensioned and simulated with any credibility by comprehensive, sophisticated techniques. As Enache [1991] put it, large-scale analyses and computer models have failed to "capture human experience". They have thus failed to replace "fantasies and emotions" with "facts" [Healy & Ascher 1990].

Modelling and analytical procedures are designed to create an understanding of technical issues. The more technical a public issue, the greater the *potential* that many of the questions will lend themselves to analytical treatments. Technical analysis and modelling will happen as a matter of course if answers involving measurements are required. As House and Schull [1988 :197] observe:

> The value-laden issue is most apt to be the one requiring political attention, whereas the technical issues can be addressed by technicians and, in many cases, can be resolved in a sufficiently straightforward fashion so that there is no compelling reason to buck it up the decision chain.

Land information systems' contribution to the policy process is at the technical rather than at the "human" end of the problem solving spectrum. Providing the land information systems and their contributions are credible in policy terms, and not perceived as "black boxes that spit out garbage – not wisdom" [interviewee in Brewer 1980:140], at the very least they should be able to provide some input to the adversarial process; presenting defensible options for particular land based issues.

Despite the popularist view, land information systems analysis and modelling capabilities are limited once they attempt to represent anything outside of the spatial domain (Chapter 2). Most issues about land use and the environment, for example, will involve land-related matters where temporal and comparative concerns in the socio-economic arena are likely to be of a greater consequence than simple spatial relationships or locationally based operations. Land information systems do not deal well with these multi-dimensional "quantitative" problems [Harris & Batty 1991:29] and there is little consensus on what connection there should, or can, be between models which have been constructed to analyse problems of this kind and land information systems [Goodchild et al. 1992].

At the same time, as noted earlier, there is growing evidence that the simplification of the land information system technologies is leading to the widespread use of mono-purpose modelling and presentation software packages at all levels of government decision making, including the policy level [Knauth 1990].

Policy-oriented land information systems should therefore incorporate simple modelling functions of this kind but should not attempt to construct comprehensive analytical model capabilities which extend beyond representing and portraying locational phenomena.

LEARNING CONCERNS

Policy-oriented land information systems to assist policy understanding will need to be able to hold information in both a top-down, as well as a bottom-up data structure

The analysis of information utilisation in the policy process in the previous chapters suggested that a more significant role for land information systems in the public policy process is in furthering the understanding of the issues involved in a particular problem, rather than in providing instrumental information for reaching a decision. However, the manner in which information is structured in present-day land information systems is not well suited to this task. To enhance its conceptual utilisation, it is suggested that policy-based land information systems should possess a number of characteristics. These are briefly outlined below.

- Policy makers need to make sense of, gain insights into and perceptions about, the factors and relationships that impinge on a particular policy issue. To acquire such an understanding, they generally need to restructure, reorganise and assimilate the information they receive with their existing perceptions and knowledge of the problem. Within the time and resources available, policy makers need to deduce and make logical sense out of apparently arbitrary, and at times conflicting, signals.

  Studies in educational psychology indicate that cognitive development of new relationships is actively pursued through the processes of assimilation and accommodation before information is stored [e.g. Howard 1987:133]. It is argued that policy-based land information systems can serve no better purpose than to restructure their environment such that these cognitive insights and perceptions have a chance to occur.

- While theories about how we acquire understanding and knowledge abound, there is now general agreement that structuring information in terms of a hierarchy of concepts, from the most general to the most specific, assists learning. Even though theories differ as to which should come first, the more general ideas before the detailed facts or around the other way [e.g. Gagne et al. 1988, Ausubel 1978], all agree that both types of information are required – as the discussion on conceptual and instrumental use in the last two chapters indicated.

- There is also now a fairly wide agreement that the organisation of the knowledge a person already possesses (that is, their schemata) is the principal determinant of what will be learnt in any particular situation.

> What this implies is that meaningfulness depends on engaging appropriate schemata. If the relevant schemata do not exist, then a teacher [land information system] needs to provide a context or schema for what is to be learnt. In this way the new material can be assimilated into existing knowledge structures, and "cross-listed" with other schemata. Unless the teacher [land information system] provides these contexts, the student [the decision maker] will provide their own, which may be inappropriate.
>
> [Gage & Berliner 1984:318]

Taken together, the above factors suggest that in practice policy-based land information systems to enhance their conceptual use will need to possess the following characteristics.

- As discussed earlier in the chapter, the system and its products will need to be firmly placed in the context, and must view the problem from the perspective of the policy makers or their advisers.

- Present-day land information systems data constructs are based on the classic reductionist notion that to understand (to know) something it has to be in its simplest form. This view holds that before we can proceed from complexity to simplicity and on to knowledge, we need (i) to know how the original complex problem may be differentiated, (ii) to establish appropriate sub-goals for each task, and (iii) to have information on how these simplexes relate and interact with each other.

Cognitive psychology, however, suggests that equally important to gaining knowledge is the development of high-level concepts by which to gain understanding before acquiring knowledge at the detailed level. Irrespective of whether detail precedes concept or vice versa, policy-oriented land information systems will need to hold aggregates at specified levels of generality, derived from the information held in conventional land information systems. Data will need to be indexed, sorted and combined at several levels of complexity for each of the historical, present and predictive contexts mentioned above. Operationally then, policy-oriented land information systems will, like the NSF policy support system, file its information

> "at its finest grain, individual record," House explains. "This allows us to whip through tremendous amounts of information almost instantly. Also, we can re-aggregate these records at whatever level we want to use for a particular analysis."
>
> [Knauth 1990]

The fine grain, detailed information will be obtained from existing land information systems; the policy system will compile the aggregates.

Policy-oriented land information systems will need to support inductive as well as deductive information retrieval and modelling processes

In unstructured problem solving situations like the policy process, decision makers have to gain their understanding of the policy issues on their own, more or less. Information by which to gain this understanding comes to the policy maker largely in its raw form, in a random order and may be either relevant or irrelevant to the issue under consideration. From this information the policy maker has to abstract the general concepts, establish linkages, and select and reject information until some general understanding (i.e. structure) is achieved. This discovery or inductive mode of learning has to uncover the logic and general concepts surrounding a topic or situation.

Deductive reasoning, – that is, inferring particular instances from general relationships – by definition, requires some knowledge of the structure and form of the underlying relationships or processes. By contrast, inductive reasoning is the process of inferring general relationships from the observation of particular instances.

Both deduction and induction are necessary for the reliable development of a model. Induction is most appropriate to the analysis of problems when knowledge of the underlying processes is either unavailable or incomplete.

Land information systems impose a formal logic and structure on the information they hold (Chapter 2). The enquiry, analysis and modelling functions are based on this structure. If land information systems are to be used for discovery learning, then an appropriate set of functions such as browsing, associative and inference functions, either by programming or through knowledge-based systems, would need to be available.

Policy-oriented land information systems will need to support decision legitimation functions

Legitimising a decision *post hoc* by searching for supporting information is, as observed in Chapter 7, a common procedure in policy making. Functionally this means that, starting from a specified policy outcome, a land information system would need to be searched for information which would substantiate or collaborate the decision in defensible, formal terms. The system has to be capable of "recognising" or at least leading the policy-analyst/policy-maker to information, or relationships, which are associated with the outcome. This too is an induction process, but in this case directed towards a particular goal; that is, the procedure to be followed is the antithesis of ordinary problem solving. The land information system is now being used to derive information for a decision, whereas in ordinary problem solving the information in the system is used to derive an outcome.

The legitimation function is a special and simplified case of the inductive process described above, but should be implemented as a separate function.

Policy-based land information systems need to support multiple presentation and communication methods

The above recommendations for a policy-based land information system, if implemented, would, if the thesis is correct, result in land information system products which in form and kind are closer to meeting the needs of policy advisers and decision makers than those emanating from present-day land information systems. These "improved" information products, however, need to be effectively communicated to the policy actors in a manner and style that are meaningful and will lead to their utilisation.

Conventional land information systems are capable of presenting their information in a variety of forms on a number of media (Chapter 2). The display of spatial information in graphical, image and text form are normal functions. For policy purposes these "standard" functions will need to be augmented by such presentation and information as:

- Simplified as well as schematic cartographic and mapping functions, representations and annotations.
- Business graphics.
- Explanations of information used, its "meta-data" (source, age, reliability), the "rules" (choices) used to extract and manipulate the displayed data, plus indications of alternative data sources and options for further processing and presentation.

None of these requirements is beyond the capabilities of existing technology or systems. Like other dedicated systems, however, these functions, together with appropriate user interfaces, will need to be explicitly designed and programmed for the policy community.

Building Policy-Based Land Information Systems

There appear to be at present no land information systems designed for assisting decision making which contain the features outlined above. Where spatial decision support systems (SDSS), knowledge-based or expert land information systems have been developed, they are essentially extensions of, and based on, standard land information systems, data models, data types and operators. Their use is normally confined to providing assistance with the solution of semi-structured or ordinary problem-solving situations. According to Armstrong and Densham [1990], these kinds of decision support system are distinguished by six characteristics:

> (1) They are used to tackle ill or semi-structured problems – these occur when the problem, the decision makers' objectives, or both, cannot be fully and coherently specified. (2) They are designed to be easy to use, the often very sophisticated computer technology is accessed through a user-friendly front-end. (3) They are designed to enable a user to make full use of all data and models that are available, so interfacing routines and data base management systems are important elements. (4) The user develops a solution procedure using the models as decision aids to generate a series of alternatives. (5) They are designed for flexibility of use and ease of adaptation to the evolving needs of the user. (6) They are developed interactively and recursively to provide a multi-path approach which contrasts with the more traditional serial approach – involving clearly defined phases through which the system progresses.

Operationally, policy-based land information systems will need to have many of these features: ease of use, access to a range of data, generation of alternative "solutions" and scenarios, flexibility, and adaptation to user needs as demands change.

Spatial decision support systems generally lack a number of significant features important in the policy process. These are:

1. The system and the philosophy on which it rests is firmly based on rational models of information processing and decision making.

2. Features to reorganise, analyse and compare information in different contexts and from different perspectives are normally absent or, if available, simplistic.

3. Data representation and quality measures are confined to scientific terms.

4. They generally rely on structured, deductive information searching and modelling procedures.

Some of the other features required for a policy-based land information system are either already available (see Armstrong & Densham quotation above) or could be met by existing techniques and geographic information systems technology. For example, limited attempts have been made to include some inductive processes as part of a spatial decision support system [Walker & Moore 1988, Abel et al. 1991].

In Walker's and Moore's SIMPLE system, the deductive modelling process – that is, applying a model derived by experience at one location to identify occurrences of the same phenomena at another location – is replaced by an inductive modelling process which identifies the location of phenomena by its association with other locational attributes. At the heart of the system is a method of systematically identifying relationships between spatial objects by inducing, from sets of data, rules which describe these relationships. The method used in SIMPLE develops rules which systematically predict a pattern by examining a learning sample of objects. This sample not only contains objects of a known class, but also sets of attributes with which it is associated (correlated). Given the availability of base data in a land information system, it would appear that techniques of this kind could be used to establish associations between certain types of land use issue and certain landscape, physical or environmental properties of some portion of land in historical, present and future contexts.

A similar inductive process is used by Abel et al. [1991] in their environmental decision support system tied to an object oriented based land information system. This data base, together with sets of information delivery tools, "provides a scientist with the means to reconnoitre a region or species and the data available, to assemble a data set for analysis, to execute the analysis and to interpret the results of analysis by examining them in relation to other data."

Both systems are heavily biased towards the scientific perspective, and they neither acknowledge nor see the necessity for presenting their information in any other form. A policy support system, albeit not spatial, which starts from this perspective, is the NSF system.

> For executives, the system mimics the expertise of a seasoned analyst, serving up facts in their historical context, along with an overview of related information. For analysts, the system offers a sophisticated menu system that allows them to quickly pin-point needed data in a large, customised data base.
>
> [Knauth 1990]

Like the two spatial decision support systems mentioned above, the intent of the NSF system is to create a system that is "better at pattern recognition and hence 'learning'". To facilitate this learning, processed subsets of the main NSF data base are indexed, sorted and aggregated at several levels of complexities and placed in the context "that the decision maker will find most useful." This is achieved by a system interface which

> turns the usual natural language idea upside-down. Most natural language systems ask you a long series of questions, trying to get you to gradually narrow down the possibilities for the right answer.
>
> [Knauth 1990]

This is not a useful tool for decision makers, for two reasons: first, busy executives or speech writers often don't know exactly what they want. Second, by the time they sit through this process, most realise it would have been faster to pick up the phone and tell someone else to go look for the answer. The NSF system has therefore been designed, through a mix of pre-processed data, neural network technology and custom designed enquiry and presentation interfaces, to satisfy most requests for information within three to four minutes' response time.

There are no technical reasons why similar approaches could not be used for policy-oriented land information systems.

Conclusions

The analysis of the utilisation patterns of land information system products in the public policy process in the preceding chapters revealed that land information systems' place is potentially much more one of providing background information than information which is decisive in setting the policy process or policy objectives. It was further suggested that by design and origin, the primary role of land information systems is decision making, not as a tool for formulating concepts, discovering information linkages, or for engendering learning and understanding. This chapter has proposed a number of system design parameters to enhance the ability of land information systems to perform these functions, and thereby a system which is more policy oriented than directed towards problem solving. A conceptual design of a policy-oriented system is premised, like the embodied GIS concept of Appendix C6, on land information systems having to adapt to the whims, vagaries and dictates of the public policy process, not the other way around. They will need to undergo a paradigm shift, away from the rationalist tradition towards a conceptual basis which views these systems as an integral and normal part of the policy process for land use related policy determinations, whims and all. In Topping's [1993] words, the land information systems community

> needs to encourage a more systematic approach for getting inside the minds of policy makers and top managers and designing systems responsive to their information needs, concerns and fundamental interest.

How many of the design features of a policy-oriented land information system can actually be realised and how many will remain outside the system is difficult to say with any certainty. There are some indications that at least at the data and inductive levels some progress is already being made, and that further progress is possible. Even if it turns out that only some of the above suggestions can be implemented in practice, the others may be useful even in their conceptualised form to suggest how the land information systems community should address and interact with the policy community.

CHAPTER 10

SUMMARY AND CONCLUSIONS

> The point is that objects and happenings which are not in the end ever felt and grasped in a suitable way by anybody – which never reach any sentient being at all – cannot understandably be said to have any value. Contributing to a purely abstract imaginary entity called science will not do instead.
>
> Mary Midley

Introduction

This thesis set out to test three propositions. Firstly, that the general belief held in the land information systems community that the systems contribute to "better decisions" through the provision of better information at all levels of decision making is misplaced. Secondly, that this misconception is founded on a general failure to clearly recognise the differences in how science-based knowledge and processes are used in decision making processes for ordinary problem solving as compared to strategic problem solving (policy making) in the public domain. Lastly, the proposition that land information systems can be adapted to improve the possibility of their products being recognised as a normal input into the public policy process.

The criteria used to establish whether these propositions are true or false is taken to be whether the information from land information systems is in any way useful, or of influence, or has impact, in the public policy process. To conduct this evaluation land information systems, ordinary problem solving and the public policy process were each examined from an information interventionist perspective; that is, an attempt was made to examine what part this information played in the process, how was it used, and to what effect. On the way, through the use of a number of models, case studies and observations from the literature, a series of conclusions were derived.

In this chapter these conclusions will be summarised and used to evaluate whether the proposed thesis can be supported. The framework for this summary will be the parameters of the A VICTORY model of knowledge as a change indicator, briefly discussed in Chapter 7 and summarised in Table 10.1.

In this model the utilisation of knowledge is taken to be synonymous with planned change or innovation. Having roots in learning theory, the factors in the model are premised on the concept that the acquisition of new knowledge, through information or restructuring of existing knowledge, necessitates a change in cognition. As has been argued in previous chapters, making land information systems an integral part of the decision making process, at least at the policy extreme of the decision spectrum, is tantamount to a substantial change or "innovation". It would therefore be appropriate to use the factors of change identified in the A VICTORY model as a framework for summarising the findings of the earlier chapters.

Below, under the heading of each of the A VICTORY factors, the findings of the earlier chapters are discussed with respect to (1) the place of land information systems in ordinary decision making, (2) its role in the public policy process, and (3) the modifications required to improve the possible relevance of land information systems in the policy process.

Summary of Findings

CIRCUMSTANCE AND TIMING

More than most individuals involved in an innovation would probably care to recognise, the timing and circumstances surrounding its introduction are critical to its acceptance. Land information systems started as, and became part of, the procedural mode of planning based on system approaches to problem solving for routine administration through to strategic policy setting. At least prescriptively, problem solving and land information systems were founded on the same rationalist creed – they held the same "world view" (Table 9.1). This parity of interest was maintained at the administrative and managerial levels when the procedural planning philosophy failed to live up to expectations and governments shifted towards emphasising operational efficiency and effective information management practices. Circumstances, plus the timing of technological advances, ensured a continuing place for land information systems in the ensuing bureaucratic and operational reforms.

Table 10.1 FACTORS IN THE UTILISATION OF INFORMATION

[Based on Glaser et al. 1983:36]

ABILITY	resources, capabilities and capacity, experience of organisation to implement, sustain change / financial and social cost
VALUES	degree of accord between existing values, culture, norms and proposed change / compatibility
IDEA/INFORMATION	clear communication of new idea, evidence of validity, and credibility, complexity, ease in understanding, reversibility, availability of technical assistance, adequacy of interaction between innovator and potential users, point of origin
CIRCUMSTANCE	factors operating within the organisation at the time / dissatisfaction with status quo, pressure to change, proximity
TIMING	readiness to consider, timeliness for implementation
OBLIGATION	perceived need, or desirability to try innovation / relevance, commitment / investment of time and effort
RESISTANCE	inhibiting factors, organisational or individual / risk and uncertainty
YIELD	expected benefits or rewards of innovation / relative advantage, esteem, status

At the policy level, the abandonment of the rational planning models (if indeed they ever had been really adopted in practice) saw a severing of the supposed *direct* link between access to formal analyses and information on the one hand, and the policy process on the other. The perspectives of the land information systems and the policy communities diverged to become largely disparate and incompatible. The political and public administrative environmental circumstances had altered. I suggest that no amount of proselytising by the land information systems community is likely to change these circumstances to once again favour the rationalists' approach to strategic problem solving, on which land information systems are founded. It is in this light that the modifications proposed in Chapter 9 to bring about policy-oriented land information systems should be viewed.

Modes of problem solving and public decision making come and go, yet even if processes like the policy learning models discussed in Chapter 6 come into vogue, it is probable that policy-oriented enhancements to land information systems will still be required. For, as is pointed out by Smith and Wellar [1992],

> changes in many of the policy formation components are precipitating new rounds of concern and expectations that call for further, more sophisticated applications of IS/GIS/LIS to formulate and realize policy objectives.

While Smith and Wellar acknowledge that the statement is more by way of exhortation, the lack of evidence of instrumental use of land information systems by the policy process, as revealed in the preceding chapters, lends support to their call for a more considered approach to how land information systems should relate to the land management policy process. Indications such as these point to the necessity for land information systems to adjust to these "new" circumstances surrounding the policy process should they wish to be seen as part of the process.

Characteristically, the policy process, especially for most land management issues, is essentially socio-economic-political by nature, where analyses and technical information are usually only of peripheral value, not central to the formulation of a policy position. Technical matters, requiring technical solutions, normally do not rise to the policy level but are treated within existing policy guidelines. When formal information does enter the policy process, it is most likely to be as background information from which to gain an understanding of the issues and the arguments being advanced, and to preserve a preferred policy position.

The circumstances in which land management policy is determined may again change in the future through pressure from such events as new legislation, dissatisfaction with existing procedures, political change and crises. In each instance, land information systems will need to adapt to, be sensitive to, these variations if its capabilities are to correspond with the values and interests of the policy makers of the time.

VALUE

Formal information systems were perceived to be of value in the public policy process while there was still a degree of accord between the cultural values and norms of the two communities. But as noted in Chapter 6, formal analyses are no longer required to provide "a comprehensive factual basis for all who have to participate in the process". Present day "norms" for solving public problems are social resolution processes which, through the normal political process, are deemed to address the need to be aware of as many potential effects of policies as possible. They are viewed as an alternative to formal analysis to derive acceptable and "correct" policy options in the social and political domains. Technical, factual information and analyses are still required, depending on the nature of the issue and if it is brought into the debate by one of the interested parties. They are however no longer in the driving seat of the policy process, merely another input.

From a rationalist perspective, the evidence from both the policy and land information systems literature indicates that the value of formal procedures has been downgraded from a position during the 1960s and 1970s where, at least prescriptively, they occupied an instrumental place, to where their influence now tends to be indirect, conceptual and instructive rather than decisive. It is for these reasons that the notion of policy-oriented land information systems is proposed – to bring land information systems closer in context and method to the ways of the policy community. This entails, among other things, a recognition that the public policy process is not a discrete, means–end procedure founded on synoptic views or optimal choices; that information may not always be perceived as being of help, where obfuscation rather than clarity may be the preferred outcome from information use. It also means an acceptance of the fact that formal information, just like any rumour or piece of casual gossip, becomes a commodity – a useful resource during bargaining and negotiation by which to manipulate one's opponents and win a preferred policy position. Intrinsic worth or authenticity of the information, or the correctness of the chosen policy position, are not at issue in the process. Having land information systems accepted in this environment therefore becomes a task of defining the place of highly structured data – founded on a particular, currently out of fashion view of the world – in an imprecise, undefined and unbounded process.

The evidence from the preceding chapters suggests that this place should primarily be one of providing an environment which is conducive to creating understanding and learning about the technical, land related issues that may surround a land management problem at the policy level. For land information systems to fill such a role, their capabilities need to be extended to readily permit inductive information processing for learning about an issue as well as for accessing information to legitimise policy positions. It also necessitates land information systems being firmly placed in, and conceived, by both the policy makers and the land information systems community, as being a part of the normal policy procedure to alleviate land management issues. The evidence that land information systems as presently constituted are being viewed in this light by public decision makers is scarce indeed, notwithstanding the limitation of the knowledge utilisation methods employed to analyse the evidence (Chapter 7).

In a large measure this lack of influence is due, as was enunciated in Chapters 6 and 7, not only to the nature of the public policy process itself, but also to the fact that land information systems operate in a different contextual setting, where neither the data nor the information processing tools are sympathetic to the policy process or to the policy makers' perspective on the world. For land information systems to be of some consequence in present day policy formulation they, not the policy process, have to bridge the gap between decision making procedures at the problem solving end of the decision spectrum (Table 1.2) and those at the policy end. The reforms suggested in Chapter 9 to the contents, setting and capabilities of land information systems are designed to reduce this gap, to bring land information systems much more into line with how current policy procedures view and utilise formal information. The land information systems community cannot afford to remain aloof from the vacillations of the political world if it wishes to have a say – it has to get in there and muck it with the best.

Ultimately, however, the land information systems community needs to acknowledge that such changes cannot overcome the fundamental nature of strategic problem solving or the inherent limitations of information itself. As was noted in Chapter 4, while information can determine how a problem should be solved, it can only suggest or supply guidance as to *which* problem should be solved, and what will be considered a satisfactory outcome. The fundamental difficulty of fulfilling a number of expectations, through the selection of an appropriate mix of goals, is something which is not amenable to solution by formal information processes. It is an article of faith, of intuition, of values and ethics. All that land information systems can do is to provide information which hopefully broadens the decision makers' understanding of the issues, and perhaps help to shape and influence the *process*. Information and analysis can in no way determine the outcome of the process. As Vickers [1987:87] observes,

> problems of ethical judgement, whether set to a government or an individual, are nonetheless different from those which man-made devices are usually programmed to solve, because they are by their nature both insoluble and unspecifiable.

OBLIGATION

Cybernetic models of planning and policy were introduced as a response to the persistent perception that the problems facing society were growing more intractable, and their solutions becoming less obvious – in short, that handling this growing complexity required more and better information, analyses and models to support plans and strategies that would suggest the direction of future developments objectively and logically (Chapter 3). The root causes for this complexity have not diminished over the last two decades, but the manner in which we choose to plan and deal with it has. There is, therefore, still a political obligation on government to derive policies to keep in check, ameliorate or eliminate unforeseen cross consequences of policy choices in a tightly interwoven modern industrial society.

Modern technology is a significant contributor to this complexity. Despite the emotional and political overtones of most land management issues, as society becomes more dependent on technological know-how and scientific skills, so technology and technical knowledge will continue to be part of the solution and hence part of the public policy process. Inasmuch as land information systems are a *necessary* part of the process there will be an obligation for the policy makers to use them. "Necessary" in this case does not only mean the use of these systems in a substantive manner, to propose real answers to real problems, but also their use in a symbolic sense and as a defence in debate and argument.

As discussed in Chapter 7, Western societies perceive reasoned, "factually" based argument as being superior to all other forms of logic and decision making. Governments therefore feel obliged to justify, if not make, their decisions on rational grounds – arguing to convinced interest groups and opponents alike that their preferred policies were carefully made on the basis of objective criteria. If land information systems can be part of this symbolism, can help to create the appearance of rationality and modernity, this will not only enhance its own credibility in the eyes of policy actors but may also, in due course, find themselves being used in the rational, deductive mode of problem solving for which they are designed. While the use of a land information system for legitimation may offend the rational sensibilities of some land information system practitioners, it is a normal part of public policy formulation, a defensible use of information – just as defensible or questionable as some of the deductive models and decision rules in use by present day land information systems. A land information system needs to be able to support this symbolic decision making process if it wants to be part of the public policy process affecting land management.

But the motivation for policy makers to use land information systems also extends beyond their symbolic role of establishing credibility. Where the resolution of a land management issue depends on technical considerations, and a land information system can assist, then it will be in the *interest* of the policy makers to use the system. Although rare, the issue may simply need scientifically verified information to determine an acceptable policy. However, policy makers are more likely to use a land information system for this purpose if it possesses the policy-oriented features proposed in the last chapter.

If they do not use the system then, as discussed in Chapter 9, they run the risk of losing credibility by not possessing some piece of knowledge they should have known about. Just on the basis of defending their policy position, policy actors may have to become at least familiar with land information system techniques, to offer a critique of policy analyses prepared by adversarial agencies who are familiar with the capabilities of these systems. Again, the evidence from the previous chapters indicates that policy makers will be more motivated to use land information systems if they can help them to advance arguments which are believable, likely to bestow political advantage and likely to carry authority. How comprehensive or refined the information and analyses have been is normally not at issue, as long as the information helps to carry the day.

ABILITY

For the reasons discussed throughout the thesis, and partly summarised above, the ability of the policy process to accept existing land information system as a part of the process is limited by their disparate natures. By background, motivation, approach and environment, present day policy process and land information system do not sit well together (Table 9.1). The land information system community at times bemoans the apparent lack of influence of its "better" information products, the rejection of its models and the perceived scientific ignorance at the policy level. But as has been argued, the amount of influence on political decisions of formal analytical work is a function of the political nature of the issue plus the politician's will, ability and skill to use this formal information. It has little to do with the quality, veracity or sophistication of the work itself.

The proposal for a policy-oriented land information system is premised on giving the policy actors a greater ability to employ land information system techniques from their perspective, in providing functions and data which are meaningful in their context, to facilitate communication and interconnection between a potential information supplier and a willing user. Policy makers are under some obligation to at least defend their decisions by formal methods. Policy-oriented land information systems, it may be hoped, will provide them with the capacity and capabilities to employ them, if not for deciding an issue, at least as a means for achieving a better understanding of the factors involved. The evidence suggests that this is all that the land information systems community can reasonably hope to achieve, and it is *on the condition* that it modifies its systems to accommodate the "user needs" of the public policy world.

At the same time, as observed in Chapter 9, more and more scientific problems which have no clear-cut solutions and carry with them sharp emotional and professional divisions are likely to become part of the land management policy agenda. Scientists in general, and the land information systems community in particular, will need to recognise the legitimacy and usefulness of non-expert participation in this process. In its turn, the policy community will need to accept the inclusion of scientific contributions in a dialogue of exploration, understanding and consensus building, since there may have to be socio-political answers to what are essentially scientific problems. There is little evidence to suggest that this state of affairs has been acknowledged by either community. Building policy-oriented land information system is a step towards giving both communities an ability to commence investigating processes to handle problems of this kind.

Realistically, however, a policy-oriented land information system's ability to contribute to any one land management issue, as envisaged above, will be restricted by the practicability of assembling, maintaining and transforming the required multifarious kinds of land related information, plus their contexts. It is likely, therefore, that for the foreseeable future, the application of these systems to land management policy will be for specific types of policy issue via discrete dedicated systems, in keeping with the NSF policy support system described in the last chapter.

IDEA

This factor of utilisation of information refers to the credibility, the ease of understanding and the adequacy of the interaction between the innovator and potential user (Table 10.1). There is little doubt that land information systems have met and are meeting these criteria at the operational levels of the land management process *once* politically feasible policies have been specified. Yet, should such policies be questioned or become politically unsustainable, as happens frequently in public land management and natural resources debates, there appears to be little understanding or credibility attached to using land information systems to assist with re-establishing an acceptable policy framework.

A policy-oriented land information system aims to make the idea of using such systems in this capacity an acceptable and normal part of the land management policy process. It also aims to achieve, at the policy level, a degree of influence and impact for land information systems, by fostering conditions and information conducive to gradually comprehending a policy issue through supplying contexts from which suggestions, ideas, concepts and policy choices may be derived. Attaining at least a workable comprehension and understanding of a policy issue is a prerequisite and *necessary* step towards the formulation of a possible policy response.

It was noted in earlier chapters that land information system practitioners tend to concentrate on the instrumental worth of their systems for decision making. An equally valid role is for these systems to furbish information for learning about, and acquiring an understanding of, the factors affecting a policy situation – that is, the factors to be taken into account and their relationships and relative importance. I have suggested, since their is scant evidence of land information system influencing the policy process instrumentally (for all the reasons outlined earlier in this chapter), that *one* way of potentially improving the utilisation of land information system products in the policy process is to modify and enhance these systems to fulfil this conceptual role. Even though utilisation levels will be difficult to determine because of the limitations of current evaluation methods (Chapter 7), and are unlikely, due to the nature of the public policy process, to be comparable to those currently enjoyed at the operational level, developing systems to fill this instructive role is a valid and credible way for land information systems to strive towards their stated aim of being of consequence in the land management policy process. *Prima facie,* a policy-oriented land information system capable of undertaking this learning function will be a relevant, advantageous and compatible innovation for the policy maker, and will present few of the difficulties that the policy makers appear to be having with conventional land information system.

RESISTANCE (Willingness) AND YIELD

There is no evidence to suggest that policy makers have any sound reason to oppose the use of land information system in the land management policy process. On the contrary, if such a system were to enhance the policy maker's bargaining position, strengthen his or her credibility and help to expose weaknesses in opponents' arguments, and hence be seen to be a part of the policy solution process, then the willingness of policy makers to employ land information system based products would appear to be high.

The same applies to any other system or source of policy advice with these attributes. There is nothing particularly different about land information system in the eyes of policy makers to suggest that they would be either adopted or rejected on other grounds. The fact that a land information system represents a managed resource of integrated, scientifically verified data is an added bonus, necessary for solving technical problems, but not central to its adoption for policy purposes.

Provided land information system can become part of the policy process culture, alleviate fears of losing control and yield the kind of benefits described above, then its use in the land management process is unlikely to be resisted. Policy-oriented land information system is designed to minimise this risk and maximise the benefits of using land information systems generally.

Assessment of Thesis

Using the foregoing summary as a frame of reference, we can now proceed to investigate whether the thesis, as formulated, can be supported or whether it should be modified or rejected. Each will be examined in its turn followed by a brief summary statement.

As currently conceived and implemented, land information systems are, by function and origin, of limited use in public policy processes

Little evidence could be found of land information systems being used, either conceptually or instrumentally, to influence, determine, or otherwise affect the policy process (or its outcome) for land management and other land-related activities. I recognise that the knowledge-utilisation methods used for the assessment are themselves open to question, but the findings, nevertheless, are similar to those of a number of other reports and confirmed by the emperical evidence. Given the substantial number of systems now in operation, with an equally substantial literature, the results, while perhaps surprising to some in the land information system community, appear to be difficult to refute.

There are substantial differences between the way the decision making process operates at the policy level and the process at the management level. Specifically, no amount of information or analysis can make the decision on which policy to adopt. The question of what to do, as opposed to how it should be done is, and will always remain, a subjective choice.

This applies equally to technical issues as to non-technical ones – the choice of which technical issue to resolve is a socio-political decision. For this reason land information systems, at best, can only ever be a contributor to, but not decisive in, setting land management policy. The remaining difficulties in the utilisation of land information systems in the policy process may be traced back to this simple fact.

Decision making in ordinary problem solving is based on formal, rational procedures reliant on discrete, scientifically verified data organised on reductionist principles to support deductive analysis and modelling operations. On the whole, this is the antithesis of how policy makers prefer their data to be arranged and presented. There is therefore a fundamental difference between the information needs of the policy process and those of administration and management. There is also a fundamental difference between what present day land information systems can supply and what policy makers require.

These differences were minimised, at least prescriptively, while the planning and policy processes were both based on the same rationalist model. The advent of socially based policy processes has led to a widening cultural divide between the rational context of the land information systems and the adversarial perspective of the policy makers, even though the latter need the legitimacy of the former to defend their process. On the surface, these two subcultures do not appear to have much in common. Yet some reconciliation seems warranted – for the knowledge of the one to be wedded to the direction-giving powers of the other.

These limitations of land information systems for policy purposes are largely ignored or overlooked by land information system advocates

The stated aim, of at least some land information systems, to support or supplant decision making at the policy level would imply that the designers of these systems understand the public policy process. There is not much evidence to suggest that such an understanding does in fact exist. The public policy process is rarely mentioned in the literature, even in the context of land management, and when it is, the tendency is to confuse it with (rational) decision making.

As a consequence, the support that land information systems try to lend to the policy process tends to be couched in the wrong terms, placed in an unsuitable context, based on inappropriate data and analysed using methods that may well be incomprehensible to the policy maker.

Policy makers, for a variety of reasons, do not always see analytical techniques as useful to the policy process. On the whole these rational methods are not conducive to decision processes which are subjective, continuous and informal, where there are doubts about anyone's ability to identify or to solve a problem, or even to know when it has been solved. Formal methods such as those offered by land information systems seem to be able to contribute little to activities which represent adjustments between competing pressures, and which decide winners and losers through the political process.

Where formal information does enter the policy process it will be more as a tool for bargaining than for deciding, for defending a position rather than determining what is optimal, for uncovering who has an interest in the issue rather than uncovering absolute truths.

Few factors of this kind have entered the literature when the place of land information systems in land management policy issues is mentioned. Few land information practitioners seem to have recognised the consequences of the policy process abandoning prescriptive procedures on the usefulness of these systems at this level of problem solving.

Land information systems' data and functional models can be modified to enhance the chances of these systems being utilised in the land management policy process

It is highly improbable that the public policy process will change sufficiently to readily accept, or interact with, land information systems as presently conceived and implemented. If the land information systems community wishes to be of some moment in the policy process, as the survey of the literature suggests they do, then these systems will need to be modified for the requirements of the policy arena.

Modifications and extensions to existing land information systems to achieve this goal appear possible. These include extended data types, data structures, inductive as well as deductive reasoning functions, contextual changes and enhanced presentation capabilities. The purpose is to construct a spatially based information system that places information in the policy makers' context, facilitates learning, suggests rather than directs actions and encourages use. By its nature, the (land management) policy community would more readily accept such a policy-oriented land information system.

The technology for implementing land information systems with many of these features is largely available. The requirements for a policy-oriented land information system, even if they are not implemented, also serve to indicate how the land information system community *should* view the policy process, as distinct from how this community is perceiving it today.

Concluding Remarks

Land information systems are, and will continue to be, influential in land management decision making and other land-related problem solving tasks for administration and management. The question that has been addressed in this dissertation is whether that influence extends to the policy process. With few exceptions these systems have been found wanting.

Despite the essentially political nature of the policy process there will remain, simply because of the complexity of modern society, large areas where technocratic information will be needed, if not to influence the outcome of debate then at least to fashion its form and direction. This is all I believe the land information systems community can reasonably expect to achieve.

REFERENCES

AACLI (1987), Recent Developments in Land Information Systems, Australasia. Australasian Advisory Committee on Land Information, Australian Government Publishing Service, Canberra.

AACLI (1989), Status Report – Commonwealth – September 1989, Australian Advisory Committee on Land Information, Australian Government Publishing Service, Canberra.

Abel, D.J., Ackland, R., Cameron, M.A., Smith, D.F., Walker, S.K., & Yap, S.K. (1991), EDSS: A Prototype for the Next Generation of Spatial Information Systems. AURISA 91, Australasian Urban and Regional Information Systems Association, Wellington, pp 66–77.

Ackoff, R.L. (1957), Towards a Behavioural Theory of Communication. Management Science, 4, pp 218–234.

Ackoff, R.L., Gupta, S.K., & Minas, S.J. (1962), Scientific Method: Optimizing Applied Research Decisions, New York, John Wiley.

Akillian, M.H. (1975), A more perfect union – A report on our knowing the land, America, New England Section of the American Congress on Surveying and Mapping.

Alexander, E., & Hart, A.L. (1987), Communicating with Decision Makers. In Proceedings of URPIS 15, Australian Urban and Regional Information System Association, Hobart, December, pp 4.2–20.

ALIC (1987), Report January 1986–June 1987, Australian Land Information Council, Canberra.

ALIC (1988), Benefits of Land Information Systems, Australian Land Information Council, Canberra.

ALIC (1990), National Strategy on Land Information Management, Australian Land Information Council, Canberra.

ALIC (1990b), National Co-Ordination of Natural Resources Data. Report of the Second National Workshop on Natural Resources Data Management, Belconnen, Australian Land Information Council, Canberra.

Amsden, T.L. (1988), GIS and Risk Assessment, Dangerous and Wonderful Tools. Proceedings of the 1988 Annual Conference of the Urban and Regional Information Systems Association, Los Angeles, Vol. IV, pp 222–225.

Anderson, J.E. (1984), Public Policy Making, New York, Holt, Rinehart and Winston, 3rd edition.

Anderson, N.M. (1989), ICOIN Infrastructure. In Proceedings of a Forum on the Inland Waters, Coastal and Ocean Information Network, Fredericton, Champlain Institute, pp 4–17.

Annells, R, (1987), Land information in land management (private communication).

Anscombe, F.J. (1964), Some Remarks on Bayesian Statistics. In Shelley, M.W. and Bryan, G.L., Human Judgement and Optimality, New York, John Wiley.

Anthony, R.N., Dearden, J., & Bedford, N.M. (1984), Management Control Systems, Homewood, Ill., Richard D. Irwin, 5th edition.

Argyris, C. (1971), Management Information Systems: The Challenge To Rationality and Emotionality. Management Science, 17, 6, pp B275–B292.

Argyris, C. (1973), Some Limits of Rational Man Organizational Theory, Public Administration Review, 33, pp 253–267.

Armstrong, M.P., & Densham, P.J. (1990), Database organisation strategies for spatial decision support systems, International Journal of Geographic Information Systems, 4, 1, pp 3–20.

AURISA (1985), Report of the Working Group on Statewide Parcel-Based Land Information Systems in Australasia. Technical Monogram No. 1, Australian Urban and Regional Information Systems Association.

Ausubel, D.P., Novak, J.D., & Hanesian, H. (1978), Educational Psychology: A Cognitive View. New York, Holt, Rinehart and Winston, 2nd edition.

Ayers, E.H. (1975), Where Do We Go From Here, in Proceedings of the North American Conference on Modernization of Land Data Systems, Washington, MOLDS, pp 439–445.

Barrett, S., & Hill, M. (1984), Policy, Bargaining and Structures in Implementation Theory. Policy and Politics, 12, 3, pp 219–240.

Barrett, S., & Leather, P. (1984), Information Technology in Planning Practice. Environmental and Planning Committee Report No.3, Economic and Social Research Council, London.

Barrett, S.M., & Masters, R.J. (1985), Information Systems for Policy Planning. In England, J.R. et al. (Eds) Information Systems for Policy Planning in Local Government. Harlow, Essex, Longmans.

Batty, M. (1988), Educating Planners in Information Technology: Experiences from Developed and Developing Countries. In, Information Systems for Government and Business, United Nations Centre for Regional Development, Nagoya, Japan.

Batty, M. (1991), New Technology and Planning, Town Planning Review, 62, 3, pp 269–294.

Beck, J.A. (1989), A Geographic Information and Modelling System for the Management of Wildfire Incidents. Proceedings of URPIS 17, Perth, pp 474–484.

Bedard, Y. (1986), A Study of the Nature of Data Using a Communication Based Conceptual Framework of Land Information Systems, XVIII FIG Conference, Toronto, pp 309.3/2–3/15.

Beecroft, D. (1986), The Planning Office, or, How not to Store Information, Proceedings of URPIS 14, Australian Urban and Regional Information System Association, Melbourne, November, pp112–128

Bennett, J.L. (1983), Analysis and Design of the User Interface for Decision Support Systems. In Bennett, J.L. Building Decision Support Systems, Reading–Ma, Addison-Wesley.

Benveniste, G. (1977), The Politics of Expertise. San Francisco, Boyd and Fraser.

Berkeley, D., & Humphreys, P. (1982), Structuring Decision Problems and the Bias Heuristic. Acta Psychologica, 50, pp 201–252.

Berry, J.F., & Cook, C.M. (1982), Managing Knowledge as a Corporate Resource. In Horton, F.W. and Marchand, D.A. (Eds), Information Management in Public Administration, Arlington, Information Resources Press.

Black, C.E. (1967), The Dynamics of Modernization, New York, Harper & Row.

Blandin, J.S., & Brown, W.B. (1977), Uncertainty and Management's Search for Information. IEEE Transactions on Management, 24, 4, pp 114–119.

Blau, P.M. (1963), The Dynamics of Bureaucracy, Chicago, University of Chicago Press.

Blumberg, D.F. (1980), The State-of-the-Art in Implementing "Successful" Management Oriented Urban and Regional Information Systems. In Papers of the Annual Conference of the Urban and Regional Information Systems Association, Toronto, August, pp 2–23.

Bolan, R.S., & Nutall, R.L. (1975), Urban Planning and Politics, Lexington, Lexington Press.

Booth, T. (1990), Researching Policy Research. Knowledge: Creation, Diffusion, Utilization, 12, 1, pp 80–100.

Bowman, M. (1979), Australian Approaches to Environmental Management: The Response of State Planning, Hobart, Environmental Law Reform Group.

Bozeman, B., & Fitzgerald, M. (1979), Social Structures for the Enhancement of Scientific Information in Urban Policy-Making and Management. Urban Systems, 3, pp 163–175.

Braybrooke, D., & Lindblom, C.E. (1963), A Strategy of Decision, New York, Collier-Macmillan.

Breheny, M.J. (1984), Policy, Implementation and Information: A Review of Changing Roles and Requirements. Proceedings of URPIS 12, Australian Urban and Regional Information System Association, Wollongong, November, unbound, p 13.

Brewer, G.D. (1973), Politicians, Bureaucrats, and the Consultant, New York, Basic Books.

Brewer, G.D. (1980), On Duplicity in the Modelling of Public Problems. Simulation, April, pp 140–143.

Brown, I.W. (1985), Land Potential and Development Monitoring System. In England, J.R. et al (Eds), Information Systems for Policy Planning in Local Government, Essex, Longman.

Brown, P.J.B. (1984), Monitoring and Regional Information Systems under Uncertainty. In Nijkamp, P. and Rietveld, P. (Eds) Information Systems for Integrated Regional Planning, Amsterdam, North Holland.

Bruner, J.S. (1961), The Process of Education, Cambridge, Mass., Harvard University Press.

Bruner, J. (1970), Reason, Prejudice and Intuition. In, Tiselius, A. and Nilsson, S. (Eds), The Place of Value in a World of Facts, New York, John Wiley & Sons.

Buckley, W. (1983), Signals, Meaning and Control in Social Systems. In Machlup, F. and Mansfield, U. (Eds) The Study of Information, New York, Wiley & Sons.

Burroughs, P.A. (1986), Principles of Geographical Information Systems for Land Resources Assessment, Oxford, Clarendon Press.

Byrne, P.A.E., & Strachan, A. (1992), The Use of GIS in the Preparation of Mineral Extraction Planning Application: a Case Study/Evaluation. In Rideout, T.W. (Ed) Geographic Information Systems and Urban Planning, Edinburgh, Planning and Environmental Study Group, Institute of British Geographers.

Cahill, A.G., & Overman, E.S. (1990), The Evolution of Rationality in Policy Analysis. In Nagel, S.S., Policy Theory and Policy Evaluation, New York, Greenwood Press.

Calkins, H.W., Onsrud, H.J., & Obermeyer, N.J. (1989), Use and Value of Geographic Information. Initiative 4 Specialist Meeting Summary Report, NCGIA Technical Paper 89–6, Orono, University of Maine.

Caplan, N. (1975), The Use of Social Science Information by Federal Executives, in Lyons, G.M. Social Research and Public Policies, Hanover, New Hampshire, Dartmouth College.

Caplan, N. (1977), A Minimal Set of Conditions Necessary for the Utilization of Social Science Knowledge in Policy Formulation at the National Level. In Weiss, C.H. (Ed) Using Social Science Research in Public Policy Making, Lexington, Mass., Lexington Brooks.

Caplan, N. (1979), The Two-Communities Theory of Knowledge Utilization. American Behavioural Scientist, 22, 3, pp 459–470.

Caplan, N., Morrison, A., & Stambaugh, R.J. (1975), The Use of Social Science Knowledge in Policy Decisions at the National Level. Centre for Research on Utilization of Scientific Knowledge, University of Michigan, Ann Arbor.

Carter, E. (1979), Patterns of Information Use in Planning. In Goodall and Kirby, A. (Eds) Resources and Planning, Oxford, Pergamon Press.

Castberg, F. (1970), The Value of Values. In Teiselius, A. and Nilsson, S. (Eds), The Place of Value in a World of Facts, New York, John Wiley & Sons.

CEPA (1992), Development of a National State of the Environment Reporting System, Discussion Paper, Canberra, Commonwealth Environment Protection Agency.

Chadwick, G. (1971) A System View of Planning, Oxford, Pergamon Press.

Chapman, R.J.K. (1990), Information Diffusion: Reconciling Scientific Knowledge and Public Policy. Prometheus, 8, 2, pp 240–256.

Chatterton, W.A., & Epstein, E.F. (1984), Legal Issues in the Development of Land Information Systems. Seminar on the Multipurpose Cadastre: Modernising Land Information Systems in North America, University of Wisconsin-Madison, December, pp 203–209.

Chorley, Lord (Chairman) (1987), Handling Geographic Data, Report of the Committee of Enquiry, London, HMSO.

Churchman, C.W. (1968), Challenge to Reason, New York, McGraw Hill.

Churchman, C.W. (1975), What is Information for Policy Making? In Kochen, M. (Ed) Information for Action, New York, Academic Press.

Churchman, C.W. (1977), A Philosophy for Complexity. In Linstone, H.A. and Simmonds, W.H.C. (Eds) Future Research New Directions, Reading, Mass., Addison-Wesley.

Ciarlo, J.A. (1981), Utilizing Evaluation: Concepts and Measurement Techniques, Beverly Hills, CA, Saga.

Clapp, J.L., & Niemann, B.J. (1977), North American Land Information Systems: An Overview with Recommendations. XVth FIG Conference, Sweden, Session 508/705.05.

Clapp, J.L., & Niemann, B.J. (1980), Land Records: Cost, Issues and Requirements. The Planning and Engineering Interface with a Modernized Land Data System, New York, American Society of Engineers.

Clapp, J.L., McLaughlin, J.D., Sullivan, J.G., & Vanderohe, A.P. (1989), Toward a Method for the Evaluation of Multipurpose Land Information Systems. URISA Journal, 1, 1, pp 39–45.

Coates, V.T., & Finn, B. (1979), A Retrospective Technology Assessment: Submarine Telegraphy: The Transatlantic Cable of 1866. San Francisco, San Francisco Press.

Cook, N.C., & Potter, C.A., (1992), Targetting Environmental Policy - Developing a GIS Methodology. In Rideout, T.W. (Ed) Geographic Information Systems and Urban Planning, Edinburgh, Planning and Environmental Study Group, Institute of British Geographers.

Coombs, C.H. (1975), Portfolio Theory and Measurement of Risk. In Kaplan, M.F. and Schwartz, S. (Eds) Human Judgement and Decison Processes, New York, Academic Press.

Cox, A. (1984), Adversary Politics and Land, Cambridge, Cambridge University Press.

Craig, W. (1985), The Minnesota Land Management Information System – Ten Years Later. Proceedings of URPIS 13, Australian Urban and Regional Information Systems, Adelaide, pp 281–290.

Crawford, J. (1982), Information for the Government Policy-Maker and Administrator. Proceedings of URPIS 10, Australian Urban and Regional Information Systems, Sydney, pp 230–254.

CSIRO (1983), Papers of the Workshop on Databases in the Natural Sciences. CSIRO, Brisbane.

Dakan, W. (1985), From Data Management to Data Analysis: Policy Applications of Geostatistics. In Papers from the 1985 Annual Conference of the Urban and Regional Information Systems Association, Vol. II, pp 200–211.

Dale, P.F., & McLaughlin, J.D. (1988), Land Information Management, Oxford, Clarendon Press.

Dangermond, J. (1983), A Classification of Software Components Commonly Used in Geographic Information Systems. In Peuquet, D. and O'Callaghan, J. (Eds) Proceedings of United States/Australia Workshop on Design and Implementation of Computer Based Geographics Information Systems. Amherst NY: IGU Commission on Geographic Data Sensing and Processing, pp 70–91.

Danziger, J.N., Dutton, W.H., Kling, R., & Kraemer, K.L. (1982), Computers and Politics, New York, Columbia University Press.

Date, C.J. (1985), An Introduction to Database Systems, 4th Ed. Reading, Mass., Addison Wesley.

Davis, F.W., Storms, D.M., Estes, J.E., Icepan, J., & Scott, J.M. (1990), An information systems approach to the preservation of biological diversity. International Journal of Geographical Information Systems, 4, 1, pp 55–78.

Davis, F., & Weller, P. (1993), Approaches to Strategic Management. Draft Paper prepared for the Resource Assessment Commission, Centre for Australian Public Sector Management, Griffith University.

Davis, G.B., & Olson, M.H. (1985), Management Information Systems, New York, McGraw-Hill.

Davis, H.R. (1973), Change and Innovation. In Feldman, S. (Ed) The Administration of Mental Health Services, Springfield, Charles Thomas, pp 289–341.

Davis, H.R., & Salasin, S.E. (1975), The Utilization of Evaluation. In Struening, E.L. and Guttentag, M., Handbook of Evaluation Research, Beverly Hills, Sage, pp 621–667.

Davis, J.R., & Greenhalgh, P.V. (1980), Policy Analysis: A Test in the Hunter Valley. Technical Memorandum 80/21, Canberra, Division of Land Use Research, CSIRO.

DCDB Projecy Team (1983), Digital Cadastal Data Base Systems Analysis Study, Adelaide, Department of Lands.

De Man, W.H.E. (Ed) (1984), Conceptual Framkework and Guidelines for Establishing Geographic Information Systems (Preliminary Version), Paris, UNESCO, Document PGI-84/WS/20.

Denman, D.R. (1972), Land Use, London, George Allen & Unwin.

Dery, D. (1984), Problem Definition in Policy Analysis, Lawerence, Kansas, Kansas University Press.

Dickey (1972), Adaptive Diagnosis of Problems. In Brinkers, H.S. (Ed) Decision Making: Creativity, Judgement and Systems, Columbus, Ohio State University Press.

Downs, A. (1967), A Realistic Look at the Final Payoffs from Urban Data Banks. Reprinted in Melanson, P.H. (1973), Knowledge, Politics and Public Policy. Cambridge, Mass., Winthrop.

Dror, Y. (1967), Policy Analysts: A New Professional Role in Government Service. Reprinted in Melanson, P.H. (1973), Knowledge, Politics and Public Policy. Cambridge, Mass., Winthrop.

Dror, Y. (1983), Basic Concepts in Policy Studies. In Nagel, S.S. (Ed) Encyclopedia of Policy Studies, New York, Marcel Dekker, pp 3–10.

Dueker, K.J. (1992) Role and Use of IS/GIS in Assessing Land Use/Transportation Plans. Proceedings of URISA '92. Vol V, pp 168–176.

Dunn, W.N., Holzner, B., & Shahidullah, M. (1987), An Accounting Scheme for Designing Science Impact Indicators. Knowledge: Creation, Diffusion, Utilization, 9, 2, pp 173–204.

Dutton, W.H. (1982), Politics, Planning and Modelling. International Journal of Policy Analysis and Information Systems, 6, 1, pp 65–89.

Dutton, W.H., Danziger, J.N., & Kraemer, K.L. (1980), Did The Policy Fail?: The Selective Use of Automated Information in the Policy-Making Process. In Ingram, H.M. and Mann, D.E. (Eds) Why Policies Succeed or Fail, Beverley Hills, Sage, pp 163–184.

Edmunds, S., & Letey, J. (1973), Environmental Administration, New York, McGraw-Hill.

Eells, E. (1983), Rational Decisions and Causality. Camb., Cambridge University Press.

Eilon, S. (1985), Editorial: Structuring Unstructured Decisions. OMEGA International Journal of Management Science, 13, 5, pp 369–377.

El Sawy, O.A. (1985), Personal Information Systems for Strategic Scanning in Turbulent Environments: Can the CEO Go On-Line? MIS Quarterly, 9, 1, pp 53–60.

Emery, F.E. (1976), Systems Thinking, Middlesex, Penguin

England, J.R. (1985), The Census of Employment. In England, J.R. et al (Eds), Information Systems for Policy Planning in Local Government, Essex, Longman.

Enache, M. (1991), Maximizing the Value of Information in Urban Policy-Making. Proceedings of the 1991 Annual Conference of the Urban and Regional Information Systems Association, San Fransisco, Vol. IV, pp 65–76.

Environment Canada (1983), Stress on Land, Folio No. 6, Policy Research and Development Branch, Lands Directorate, Environment Canada, Ottawa.

Epstein, E.F. (1988), Legal and Institutional Aspects of Global Databases. In Mounsey, H. and Tomlinson, R.F. (Eds) Building Databases for Global Science, London, Taylor & Francis.

Epstein, E.F., & Duchesneau, T.D. (1984), The Use and Value of a Geodetic Reference System. Report, University of Maine and the Federal Geodetic Control Committee Research Grant NA82AA-D-00016.

Ernst, R.L., & Yovits, M.C. (1972), Information Science as an Aid to Decision-Making. In Brinkers, H.S. (Ed) Decision Making: Creativity, Judgement and Systems, Columbus, Ohio State University Press.

Etzioni, A. (1968), The Active Society. New York, Free Press.

Feinberg, G. (1975), How to Know Where We are Going and Why. In Kochen, M. (Ed) Information for Action, New York, Academic Press.

Fellar, I., King, M.R., Menzel, D.C.,O'Connor, R.T., Wissel, P.A. and Ingersoll, T., (1979), Scientific and Technological Information in State Legislatures. American Behavioural Scientist, 22, 3, pp 417–436.

Forester, J. (1982), Planning in the Face of Power. Journal of the American Planning Association, 48, pp 67–80.

Forester, J. (1985), Practical Rationality in Planmaking. In Breheny, M.J. and Hooper, A.J. Rationality in Planning, London, Pion.

Forrest, E. (Ed) (1990) Intelligent Infrastructure Workbook: A Management-Level Primer on GIS. A-E-C Automation Land Newsletter, Fountain Hill, A2.

Forum (1992), Forum of Lands Ministers – Darwin July 1992. Agenda Papers.

French, S.P., & Belkap, R.K. (1991), Analyzing Rural Development Policies Using a Geographic Information System, Proceedings of URISA '91, Vol. 1, pp 1–15.

Funtowicz, J.O., & Ravetz, J.R. (1990), Uncertainty and Quality in Science for Policy, Dordrecht, Kluwer.

Gage, N.L., & Berliner, D.C. (1984), Educational Psychology. 3rd edition. Boston. Haughton Mifflin.

Gagné, R.M. (1970), The Condition of Learning, New York, Rinehart and Winston.

Gagné, R.M., Briggs, L.J., & Wager, W.W. (1988), Principles of Instructional Design, New York, Holt Rinehart and Winston.

Galbraith, J. (1973), Designing Complex Organizations, Menlo Park, Addison-Wesley.

Geertman, S. (1990), GIS as a Support System for Designing and Evaluating Urban Expansion Alternatives. Proceedings of the 1990 Annual Conference of Urban and Regional Information Systems Association, Edmonton, Vol. II, pp 164–173.

Gelinas, R. (1984), Land Use Monitoring Methodology Using Canada Land Data System. In Hamilton, A.C. and McLaughlin, J.D. The Decision Maker and Land Information Systems, Ontario, Canadian Institute of Surveying.

GIS World (1991), International GIS Sourcebook, Fort Collins.

Glaser, E.M., Abelson, H.H., & Garrison, K.N. (1983), Putting Knowledge to Use. San Francisco, Jossey-Bass.

Goldberg, M.A. (1985), The Irrationality of 'Rational' Planning: Exploring Broader Bases for Planning and Public Decisionmaking. In Breheny, M.J. and Hooper, A.J. Rationality in Planning, London, Pion.

Gordon, L.A., Miller, D., & Mintzberg, H. (1975), Normative Models in Managerial Decision-Making, New York, National Association of Accountants.

Gorry, G.A., & Morton, M.S.S. (1971), A Framework for Management Information Systems. Sloan Management Review, 13, 1, pp 55–70. Reprinted in Rapport, A. (1975), Information for Decision Making, Englewood Cliffs N.J., Prentice-Hall, 2nd Edition.

Goodchild, M.F., Guoqing, S., & Shiren, Y. (1992), Development and test of an error model for catagorical data, International Journal of Geographic Information Systems, 6, 2, pp 87–104.

Graham, R. (1987), Information and politicians, is there any point?(private communications)

Grainger, K(1991), Information for Public Safety and Emergence Management: The Queensland ESMAP Project. AURISA '91, Australasian Urban and Regional Information Systems Association, Wellington, November, pp 118–130.

Ham, C., & Hill, M. (1984), The Policy Process in the Modern Capitalist State, Brighton, England, Wheatsheaf Books.

Hambleton, R. (1986), Rethinking Policy Planning, SAUS, University of Bristol.

Hamilton, A.C., & Williamson, I.P. (1984), A Critique of the FIG Definition of 'Land Information Systems'. In Hamilton, A.C. and McLaughlin, J.D. The Decision Maker and Land Information Systems, Ontario, Canadian Institute of Surveying.

Hammond, K.R., Stewart, T.R., Brehmer, B., & Steinmann, D. (1975), Social Judgement. In Kaplan, M. and Schwartz, S. (Eds) Human Judgement and Decision Processes, New York, Academic Press.

Hammond, K.R., McClelland, G.H., & Mumpower, J. (1980), Human Judgement and Decision Making, New York, Praeger.

Hanna, E.J., & Wagner, G.M. (1985), The Development of a Land-Based Information System for the City of Adelaide. In Proceedings of URPIS 13. Australian Urban and Regional Information System Association, Adelaide, November, pp 91–110.

Harper, B. (1984), The West Australian Land Information System. National Conference on Better Land-Related Information for Policy Decisions, Adelaide, November, pp 64–86.

Harris, B. (1985), Rationality and Its Enemies. In Breheny, M.J. and Hooper, A.J. Rationality in Planning, London, Pion.

Harris, B., & Batty, M. (1992), Locational Models, Geographic Information, and Planning Support Systems, NCGIA Technical Paper 92–1, Santa Barbara.

Harrison, A.J. (1977), Economics and Land Use Planning, London, Croom Helm.

Hart, A.L. (1987), New South Wales Land Information System, Status Report 1987. In Proceedings of URPIS 15, Australian Urban and Regional Information System Association, Hobart, December, pp 4.3–36.

Hart, S.L. (1986), Managing Knowledge in Policymaking and Decisions. Knowledge: Creation, Diffusion, Utilization, 8, 1, pp 94–108.

Havelock, R.G. (1975), Research on the Utilization of Knowledge. In Kochen, M. (Ed) Information for Action, New York, Academic Press.

Havelock, R.G. (1977), Information Professionals as Change Agents. Drexel Library Quarterly, 13, 2, pp 48–61.

Healey, P.G., McDougall, G., & Thomas, M.J. (1982), Planning Theory: Prospects for the 1980s, Oxford, Pergamon Press.

Healy, D. (1990), Vermont GIS (private communication).

Healy, R., & Ascher, W. (1990), Incorporating Environmental Information in Natural Resource Policy Making. A paper presented at the Annual Meeting, Association for Public Policy Analysis and Management, October, San Francisco, p 21.

Heclo, H. (1974), Social Policy in Britain and Sweden, New Haven CT, Yale University.

Hemmens, G.C. (1975), Implementing the Integrated Municipal Information Systems Concept:The Charlotte, North Carolina Case. 57th Annual Conference, American Institute of Planners, San Antonio p 21.

Henderson-Sellers, B., & Henderson-Sellers, A. (1990), The Need for Management Information Systems for Government Planning Strategies to Prepare for the Enhanced Greenhouse Effect. Prometheus, 8, 2, pp 304–319.

Hill, M. (1985), Can Multiple-Objective Evaluation Methods Enhance Rationality in Planning? In Breheny, M.J. and Hooper, A.J. Rationality in Planning, London, Pion.

Hogeweg-De-Haart, H.P. (1984), Characteristics of Social Science Information: A Selective Review of the Literature. Part II. Social Science Information Studies, 4, pp 15–30.

Hollings, C.S. (1977), The Curious Behaviour of Complex Systems: Lessons from Ecology. In Linstone, H.A. and Simmonds, W.H.C. (Eds) Future Research New Directions, Reading, Mass., Addison-Wesley.

Holzner, B., Dunn, W.N., Shahidullah, M., & Hegedus, A.M. (1987). The Architecture of Knowledge Systems. Knowledge: Creation, Diffusion, Utilization, 9,2, pp 205–232.

Horton, F., & Marchand, D.A. (Eds) (1982), Information Management in Public Administration, Arlington, Information Resources Press.

House, P.W. (1982), The Art of Public Policy Analysis. Beverly Hills, Sage Publications.

House, P.W., & Schull, R.D. (1988), Rush to Policy, New Brunswick, Transaction Books.

Howard, R.W. (1987), Concepts and Schemata, London, Cassell Educational.

Humphries, A.M. (1985), Property Information Systems. In England, J.R. et al. (Eds), Information Systems for Policy Planning in Local Government, Essex, Longman.

Humphries, B. (1984), The Crisis in Land Management. In Hamilton, A.C. & McLaughlin, J.D. (Eds), The Decision Maker and Land Information Systems, Ottawa, Canadian Institute of Surveyors.

Huxhold, W.E. (1984), Modernizing Land Information Systems for City Planning and Management: Problems and Opportunities. Seminar on the Multipurpose Cadastre: Modernizing Land Information Systems in North America, University of Wisconsin-Madison, December, pp 109–129.

Huxhold, W.E. (1988), Modernizing Land Information Systems for City Planning and Management: Problems and Opportunities. Reprinted in Dahlberg, R.E., McLaughlin, J.D. and Niemann, B.J. (1989), Developments in Land Information Management, Washington Institute of Land Information.

Huxhold, W.E. (1991), Introduction to Urban Geographic Information Systems, New York, Oxford University Press.

Inbar, M. (1979), Routine Decision-Making: The Future of Bureaucracy. Beverley Hills, Sage Publications.

Ingles, A., & Woods, M. (1987), The Use of an Automatic Geographic Information System in Land Use Planning for Crown Forests in Tasmania. In, Proceedings of URPIS 15, Australasian Urban and Regional Information Systems Association, Hobart, December, pp 4.4–29.

Ingram, H. (1990), Implementation: a review and suggested framework. In Lynn, N.B. & Wildavsky, A. (Eds), Public Administration: the state of the discipline, New Jersey, Chatham House.

Ingram, M.I., & Mann, D.E. (1983), Environmental Protection Policy. In Nagel, S.S. (Ed) Encyclopedia of Policy Studies, New York, Marcel Dekker, pp 687–725.

Inkeles, A. (1975), Problems in the Utilization of Data for Policy Making. In Kochen, M. (Ed) Information for Action, New York, Academic Press.

Insignores, M., & Terry, D. (1991), Geographic Information Systems in Traffic Control. Proceedings of the 1991 Annual Conference of the Urban and Regional Information Systems Association, San Francisco, Vol 1, pp 135–144.

Inter-Department Committee S.A. (1981), Report of the Enquiry into the Development of a Digital Cadastral Data Base for South Australia.

Ive, J.R., & Cocks, K.D. (1988), LUPIS: a Decision Support System for Land Planners and Managers. In Newton, P.W., Taylor, M.A., & Sharp, R., Desktop Planning: Microcomputer Applications for Infrastructure and Services Planning and Management; Melbourne, Hargreen.

Janis, I.L., & Mann, L. (1977), Decision Making. New York, The Free Press.

Jenkins, W.I. (1978), Policy Analysis. London, Martin Robertson.

Johnston, C. (1983), Co-ordination of Land Information Systems, Sydney Water Board/Woollongong City Council, Proceedings of URPIS 11, Australian Urban and Regional Information Systems Association, Brisbane, November, pp 9B10–15.

Jones, C.O. (1977), An Introduction to the Study of Public Policy. North Scituate, Mass., Duxburg Press.

Jones, G. (1984), Senate Standing Committee-Inquiry into Land Use Policy. National Conference on Better Land-Related Information for Policy Decisions, Adelaide, November, pp 51–63.

Jones, K. (1984), Opening Speech. National Conference on Better Land Related Information for Policy Decisions, Adelaide, November, pp 22–29.

Kaplan, M.F. (1975), Information Integration in Social Judgement: Interaction of Judge and Information Components. In Kaplan, M.F. and Schwartz, S. (Eds) Human Judgement and Decision Processes, New York, Academic Press.

Kassouf, S. (1970), Normative Decision Making. Englewoods Cliffs NJ, Prentice-Hall.

Kast, F. (1968), Systems Concepts and Organization Theory. In Le Breton, P.P. (Ed) Comparative Administrative Theory, Seattle, University of Washington Press.

Keen, P.G.W. (1981), Information Systems and Organizational Change. Communications of ACM, 24, 1, pp 24–33.

Keen, P.G.W., & Morton, M.S.S. (1978), Decision Support Systems: an Organisational Perspective. Reading, Mass., Addison-Wesley.

Kevany, M.J. (1985), Assessment of Automated Mapping and Geographic Information Systems in Local Government in the U.S.A. In Papers from the 1985 Annual Conference of the Urban and Regional Information Systems Association, Ottawa,Vol. III, pp 82–88.

Kickert, W.J.M. (1980), Organization of Decision-Making. Amsterdam, North-Holland.

Kindleberger, C.P., & Topping, K. (1992) Role and Use of IS/GIS in the Planning Process. Proceedings of URISA '92. Vol. V, pp 146–167.

Kirby, M.D. (1984), Land Data and Good Decisions. National Conference on Better Land-Related Information for Policy Decisions, Adelaide, November, pp 31–43.

Klema, E.D. (1983), The Case for a National Policy Council. Research Managment, 26, pp 29–32.

Kling, R. (1978), Information Systems in Policy Making. Telecommunications Policy, 2, 1, pp 3–12.

Kling, R. (1980), Social Analysis of Computing: Theoretical Perspectives in Recent Emperical Research. Computer Surveys, 12, 1, pp 61–109.

Klosterman, R.E., & Brail, R.K. (1991), Spreadsheet Models for Urban and Regional Analysis. Paper presented at the Annual Conference of the Urban and Regional Information Systems Association, San Francisco, Vol. V, p. 25.

Knauth, K. (1990), Democratizing Science Foundation Data. Government Executive. 22, 11, pp 61–62.

Knorr, K.D. (1977), Policymaker's Use of Social Science Knowledge: Symbolic or Instrumental. In Weiss, C.H. (Ed) Using Social Science Research in Public Policy Making, Lexington, Mass., Lexington Brooks.

Kochen, M. (1975), Evolution of Brainlike Social Organs. In Kochen, M. (Ed) Information for Action, New York, Academic Press.

Koestler, A. (1970), Rebellion in a Vacuum. In, The Place of Value in a World of Facts, New York, John Wiley & Sons.

Kraemer, K.L. (1987), Information Systems and Policy Making. Proceedings of URPIS 15, Hobart, Australasian Urban and Regional Information Systems Association, pp 6.1–20.

Kraemer, K.L., & King, J.L. (1975), The URBIS Project: A Policy-Oriented Study of Computing in Local Government. Papers from the 13th Annual Conference of the Urban and Regional Information Systems Association, Seattle, Vol 1, pp 406–429.

Kraemer, K.L. & King, J.L. (1979), A Requiem for USAC. Policy Analysis, 5, 3, pp 313–349.

Kraemer, L.K., & King, J.L. (1983), The Dynamics and Evolution of Computing. Municipal Information Systems – Pacific Area Community (MISPAC) Conference, Honolulu, July, p 33.

Kraemer, K.L., Dutton, W.H. , & Northrop, A. (1981), The Management of Information Systems, New York, Columbia University Press.

Lam, A.H.S. (1986), Can Decision Theory Work for Public Planning. In Papers from the 1986 Annual Conference of the Urban and Regional Information Systems Association, Denver, Vol. IV, pp 20–28.

Lam, A. (1990), GIS in the Context of Land Use Policies. Proceedings of the 1990 Annual Conference of the Urban and Regional Information Systems Association, Edmonton, Vol. IV, pp 247–255.

Lamb, G.M. (1973), Computers in the Public Service, London, George Allan & Unwin.

LANDATA (1991), LANDATA Review. Final Report, Melbourne, Ministry of Finance.

Lansbergen, D., & Bozeman, B. (1987), Credibility, Logic and Policy Analysis. Knowledge: Creation, Diffusion, Utilization, 8, 4, pp 625–648.

Larsen, J.K., & Werner, P.D. (1981) Measuring Utilisation of Mental Health program consultation: In Ciarlo, J.A. (Ed) Utilizing Evaluation: Concepts and Measurement Techniques, Beverley Hills; Sage.

Lasswell, H.D. (1975), Constraints on the Use of Knowledge in Decision Making. In Kochen, M. (Ed) Information for Action, New York, Academic Press.

Laudon, K.C. (1974), Computers and Bureaucratic Reform, New York, Wiley.

Laws, D., Gross, M., & Fabos, J. (1989), Information Resources and Public Policy Making. Proceedings of the 1989 Annual Conference of the Urban and Regional Information Systems Association, Boston, Vol. IV, pp 160–174.

Lehmann, S. (1975), Psychology, Ecology and Community:A Setting for Evaluation Research. In Struening, E.L. and Guttentog, M. Handbook of Evaluation Research, Beverley Hills, Sage, pp 485–495.

Lerner, A.W. (1976), The Politics of Decision-Making. Beverly Hills, Sage Publications.

LIB, (1993), Managing a Vital Resource-A Strategic Directions Paper. Land Information Bureau, Tasmanian Department of Environment and Planning.

Lindblom, C.E. (1959), The Science of Muddling Through. Public Administration Review, 19, pp 79–88.

Lindblom, C.E. (1965), The Intelligence of Democracy, New York, Free Press.

Lindblom, C.E. (1979), Still Muddling, Not Yet Through. Public Administrative Review 39, 6, pp 517–526.

Lindblom, C.E., & Cohen, D.K. (1979), Usable Knowledge: Social Science and Social Problem Solving. New Haven, Conn., Yale University Press.

Linstone, H.A. (1977), Confessions of a Forecaster. In Linstone, H.A. and Simmonds,W.H.C.(Eds) Future Research New Directions, Reading, Mass., Addison-Wesley.

Linstone, H.A. (1984), Multiple Perspectives for Decision Making, New York, North Holland.

LISSC (1982), Western Australian Land Information System – Management Summary, Land Information System Advisory Committee, Perth.

LISSC (1982b), Western Australian Land Information System – System Reference Guide, Land Information System Advisory Committee, Perth.

Lohuizen, C.W. van (1986), Knowledge Management and Policy Making, Knowledge: Creation, Diffusion, Utilization, 8, 1, pp 12–38.

Lohuizen, C.W. van,, & Kochen, M. (1986), Introduction: Managing Knowledge in Policymaking, Knowledge: Creation, Diffusion, Utilization, 8, 1, pp 3–11.

LRIS (1976), Infrastructure Information Requirements in the Maritime Provinces: An Analysis, Fredericton Land Registration and Information Service, Council of Maritime Premiers.

McGrew, A.G., & Wilson, M.J. (1982), Decision Making: approaches and analysis, Manchester, Manchester University Press.

MacKinnon, A.J., & Wearing, A.J. (1980), Complexity and Decision Making. Behavioural Science, 25, pp 285–296.

McLaughlin, J.D. (1981), Surveyors, Land Information Management and the Role of Universities. The Canadian Surveyor, 35, 3, pp 303–309.

McLaughlin, J.D. (1982), Land Information Management: A Canadian Perspective. In Proceedings of URPIS 10, Australian Urban and Regional Information Systems Association, Sydney, December, pp 212–229.

McLaughlin, J.D., Dickson, P., & Morrison, W. (1985) Building the New Brunswick land information network: the property assessment component. Proceedings of the 1985 Annual Conference of the Urban and Regional Information Systems Association, Ottawa, Vol 1, pp 96–103.

McLaughlin, J.D., & Rapatz, S.L. (1991), Economics of Land Information Management. In Masters E.G. and Pollard, J.G. (Eds) Land Information Management, UNSW Monograph 14, pp 167–177

McLaughlin, J.D., & Wunderlich, G. (1983), Concepts and Approaches to Land Information Management. Proceedings of Commission 3, Congress of the InternationalFederation of Surveyors, Sofia, Bulgaria, pp 301.5/1 – 301.5/10.

MacMullin, S.E., & Taylor, R.S. (1984), Problem Dimensions and Information Traits. The Information Society, 3, 1, pp 91–111.

Machlup, F. (1980), Knowledge and Knowledge Production, Princeton, N.J., Princeton University Press.

Machlup, F. (1983), Prologue and Epilogue. In Machlup, F. and Mansfield, U. (Eds) The Study of Information, New York, Wiley & Sons.

Mack, R.P. (1971), Planning on Uncertainty, New York, Wiley.

Mackay, D.M. (1983), The Wider Scope of Information Theory. In Machlup, F. and Mansfield, U. (Eds) The Study of Information, New York, Wiley & Sons.

Marble, D.F. (1984), Geographic Information Systems and Land Information Systems: Differences and Similarities. The Decision Maker and Land Information Systems, FIG International Symposium, Edmonton, pp 35–43.

March, J.G. (1971), The Technology of the Foolish. Reprinted in Leavitt, L.R., Pondy, L.R., and Boje, D.M. (1982), Readings in Managerial Psychology, Chicago, University of Chicago Press, 3rd edition, pp 570–580.

Marchand, D.A. (1982), Needed: A New Doctrine for Information Resources Management. In Horton, F.W. and Marchand, D.A. (Eds), Information Management in Public Administration, Arlington, Information Resources Press.

Marien, M. (1984), Some Questions for the Information Society. The Information Society, 3, 2, pp 181–197.

Martin, D. (1991), Geographic Information Systems and their Socioeconomic Applications, London, Routledge.

Martino, J.P., & Lenz, R.C. (1977), Barriers to Use of Policy – Relevant Information by Decision Makers. Technological Forecasting and Social Change, 10, 4, pp 381–390.

Marwick, B. (1988), Implementing a Facilities Management Information System. Proceedings of URPIS 16, Australian Urban and Regional Information Systems Association, Sydney, November,

Mason, R.O. (1975), Basic Concepts for Designing Management Information Systems. In Rapport, A. Information for Decision Making, Englewood Cliffs, Prentice Hall, 2nd edition.

Massam, B.H. (1980), Spatial Search, Pergamon Press, Oxford.

Meiszer, N.M. (1978), Technical Problems in the Implementation of a Multipurpose Land Data System. The Fiscal Data System. In, Proceedings of the Second Molds Conference, Washington, MOLDS, pp 43–52.

Meltzer, M. (1981), Information, the Unlitmate Management Resource, New York, American Management Association.

Metlay, D. (1975), On Studying the Future Behaviour of Complex Systems. In La Porte, L.A. (Ed) Organized Social Complexity, Princeton N.J., Princeton University Press.

Michael, D.M. (1974), Speculations on Future Planning Process Theory. In Godschalk, D. (Ed) Planning in America: Learning from Turbulence, Washington DC, American Institute of Planners.

Michael, D.N. (1977), Planning's Challenge to the Systems Approach. In Linstone, H.A. and Simmonds, W.H.C. (Eds) Future Research New Directions, Reading, Mass., Addison-Wesley.

Mick, C.K. (1981), Potential STI Innovation: A Behavioral Perspective. In Mason, R.M. and Creps, J.E. (Eds) Information Services: Economics, Management and Technology, Boulder, Westview Press.

Miezis, A. (1991) Schools Assessment Management System. Proceedings of AURISA 91, Australasian Urban and Regional Information Systems Association, Wellington, pp 519–527.

Miller, R.C. (1990), Synthesizing Normative and Behavioural Theory for the Design of Social Structures. In Nagel, S.S., Policy Theory and Policy Evaluation, New York, Greenwood Press.

Miner, J.B. (1978), The Management Process: Theory, Research and Practice, New York, Macmillan, 2nd edition.

Ministry for the Environment (1992), Scoping Environmental Effects, Wellington, New Zealand.

Mintzberg, H. (1973), The Nature of Managerial Work, New York, Harper and Row.

Mintzberg, H. (1990), Strategic Formation: schools of thought. In Fredrickson, J. (Ed) Perspectives on Strategic Management, New York, Harper Business.

Mintzberg, H. (1991), Learning 1, Planning 0, Strategic Management Journal, 12, pp 463–466.

Mintzberg, H., Raisinghani, D., & Theoret, A. (1976), The Structure of 'Unstructured' Decision Processes. Administrative Science Quarterly 21, June, pp 246–275.

Mitroff, I.I. (1972), Who Looks at the Whole System? In Brinkers, H.S. (Ed) Decision Making: Creativity, Judgement, and Systems, Colombus, Ohio State University Press.

Mitroff, I.I., Emshoff, J.R., & Kilman, R.H. (1979), Assumptional Analysis: A Methodology for Strategic Problem Solving. Management Science, 25, pp 583–593.

Mitroff, I.I., & Mason, R.O. (1980), Structuring Ill-Structured Policy Issues: Further Exploration in Methodology for Messy Problems. Strategic Management Journal, 1, pp 331–342.

Mitroff, I.I., Mason, R.O., & Barabba, V.P. (1982), Policy as Argument – A Logic For Ill-Structured Decision Problems. Management Science, 28, 12, pp 1391–1404.

Moore, D. (1987), Information Systems, Policy Setting and Planning. In Proceedings of URPIS 15, Australian Urban and Regional Information System Association, Hobart, December, pp 3.1–12.

Morris, W.T. (1972), Matching Design Aids with Intuitive Styles. In Brinkers, H.S. (Ed) Decision Making: Creativity, Judgement and Systems, Colombus, Ohio State University Press.

Mortazavian, H. (1983), On System Theory and Its Relevance to Problems in Information Science. In Machlup, F. and Mansfield, U. (Eds) The Study of Information, New York, Wiley & Sons.

Nagel, S.D. (1980), Improving Policy Analysis. In Bordes, B. and Dubuch, M. (Eds) Motives and Methods of Policy Analysis. Beverley Hills, Sage.

Nagel, S.S. (1983), Policy Evaluation Methods. In Nagel, S.S. (Ed) Encyclopedia of Policy Studies, New York, Marcel Dekker, pp 65–91.

Nagel, S.S. (1988), Policy Studies, New York, Greenwood Press.

Nagel, S.S. (Ed) (1990), Policy Theory and Policy Evolution. New York, Greenwood Press.

Naisbitt, J. (1982), Megatrends, London, Macdonald.

Nanninga, P., & Tane, M. (1990) Integration through Co-ordination: Designing a GIS for the Murray-Darling Basin. Proceedings of AURISA 90: Australasian Urban and Regional Information Systems Association, Canberra, pp 281–292.

Nash, K.R. (1980), The 1980 City of Sydney Strategic Plan – the Formulation of a Corporate Policy Document at the Local Government Level. In Proceedings of URPIS 8, Australian Urban and Regional Information Systems Association, Surfers Paradise, November, pp 30.1–30.10.

Newell, A., & Simon, H.A. (1972), Human Problem Solving, Englewood Cliffs, N.J., Prentice-Hall.

Newton, P.W., Taylor, M.A., & Sharp, R. (1988), Desktop Planning: Microcomputer Applications for Infrastructure and Services Planning and Management; Melbourne, Hargreen.

Newton, P.W., Zwart, P.R., & Crawford, J.R. (1990), High Speed Communication Networks and Industrial Graphics Systems: A Preliminary Survey of Potential Leading Edge Users of FASTPAC Services, Telecom Australia, April.

Newton, P.W., Zwart, P., Cavill, M., Crawford, J.R., Edney, P., & Greener, S. (1991), GIS for Telecommunications Planning and Management, in: L. Worral (Ed) Spatial Analysis and Spatial Policy using Geographic Information Systems, London, Bellhaven, pp 75–101.

Newton, P.W., Zwart, P.R., & Cavill, M. (Eds) (1992), Networking Spatial Information Systems, Bellhaven Press, London.

Newton, P.W., Zwart, P.R., Cavill, M., & Lim, H.H. (1992), Communicating Spatial Data. Technical Computing, The ACADS Journal, 75, pp 20–22.

Niemann, B.J. (1987), Better Information for Better Decisions: No Question About It. In Proceedings of URPIS 15, Australasian Urban and Regional Information Systems Association, Hobart, December, pp 10.1–14.

Niemann, B.J., & Sullivan, J.G. (1987), Information Technology for Natural Resource Planning, Management and Monitoring: A Review and Analysis of Eleven Application. In Papers from the 1987 Annual Conference of the Urban and Regional Information Systems Association, Fort Lauderdale, Vol. I, pp 119–124.

Nijkamp, P. (1984), Information Systems: A General Introduction. In Nijkamp, P. and Rietveld, P. (Eds), Information Systems for Integrated Regional Planning, Amsterdam, North Holland.

Nijkamp, P., & Salomon, J. (1986), Telecommunication and the Tyranny of Space. In Orishimo, I., Hewings, J.D. and Nijkamp, P. (Eds) Information Technology: Social and Spatial Perspectives, Berlin, Springer-Verlag.

NRC (1980), Need for a Multipurpose Cadastre, Washington, National Academic Press.

NRIC (1989), NRIC Development – Briefing Paper, 6th June 1989. National Resource Information Centre, Canberra.

O'Connor, D. (1978), The Cartographer and Environmental Data Banks. Seminar on Mapping the Environment, Murdoch University, p 8.

Openshaw, S. (1990), Spatial Analysis and Geographical Information Systems: a review of progress and possibilities. In Scholten, H.J., & Stilwell, J.C.H. (Eds), Geographical Information Systems for Urban and Regional Planning, Dordrecht, Kluwer.

Ottens, H.L. (1990), The application of geographical information systems in urban and regional planning. In Scholten, H.J., & Stilwell, J.C.H. (Eds) Geographical Information Systems for Urban and Regional Planning, Dordrecht, Kluwer.

P.A. Consulting Services (1979), Framework For a Land Information System for Western Australia. Western Australian Government.

Palmer, D. (1984), A Land Information Network for New Brunswick. Technical Reports No. 111, Dept. of Surveying Engineering, University of New Brunswick.

Parker, E. B. (1975), Who Should Control Society's Information Resources. In Kochen, M. (Ed), Information for Action, New York, Academic Press.

Pelz, D.C. (1977), Utilization of Environmental Knowledge on Northern Michigan. Final Report: Centre for Research on Utilization of Scientific Knowledge, University of Michigan, Ann Arbor.

Pfiffner (1960), Administrative Rationality. Public Administration Review, 20, pp 125–132.

Piaget, J. (1970), Piaget's Theory In Musen, P. (Ed) Carmichael's Manual of Child Psychology, Vol 1, New York, Wiley.

Pissimissis, I. (1989), Information Systems for Urban and Regional Planning: Who is in the Driver Seat? In Proceedings of the Annual Conference of the Urban and Regional Information Systems Association, Boston, August, Vol IV, pp 54–66.

Porter, A.L., & Rossini, F.A. (1983), Technological Innovation and its Assessement. In Nagel, S.S. (Ed), Encylcopedia of Policy Studies, New York, Marcel Dekker.

Portner, J., & Niemann, B.J. (1984), An Overview of the Social Aspects of Land Records Modernization. Seminar on the Multipurpose Cadastre: Modernizing and Information Systems in North America, University of Wisconsin-Madison, December, pp 94–108.

Posner, G.J. (1978), Tools for Curriculum Research and Development: Potential Contributions from Cognitive Science. Curriculum Inquiry, 8, 4, pp 311–340.

Quade, E.S. (1982), Analysis for Public Decisions. New York, North Holland, 2nd edition.

Quadrel, M.J., & Rich, R.F. (1989), Information Selection in the House of Representatives. Knowledge: Creation, Diffusion, Utilization, 11, 2, pp 123–154.

Ramsey, J. (1994), Advising on land management issues. (private communications)

Raup, P.M. (1980), The Federal Dynamic in Land Use. National Planning Association, Washington.

Ravetz, J.R. (1987), Usable Knowledge, Usable Ignorance. Knowledge: Creation, Diffusion, Utilization, 9, 1, pp 87–116.

Ravetz, J.R. (1990), Editorial, New Scientist, 22, September.

Ray, M.L., (1990), Policy Evaluation and the Argumentation Process. In Nagel, S.S., Policy Theory and Policy Evaluation, New York, Greenwood Press.

Reade, E. (1985), An Analysis of the Use of the Concept of Rationality in the Literature of Planning. In Breheny, M.J. and Hooper, A.J. Rationality in Planning, London, Pion.

Rich, R.F. (1977), Uses of Social Science Information by Federal Bureaucrats: Knowledge for Action Versus Knowledge for Understanding. In Weiss, C.H. (Ed) Using Social Science Research in Public Policy Making, Lexington, Mass., Lexington Books.

Rich, R.F. (1979), System Analysis, Technology Assessment, and Bureaucratic Power. American Behavioural Scientist, 22, 3, pp 393–416.

Rich, R.F. (1991), Knowledge Creation, Difusion and Utilization, Knowledge: Creation, Diffusion, Utilization, 22, 3, pp 319–337.

Rich, R.F., & Goldsmith, N.M. (1983), The Utilization of Policy Research. In Nagel, J.J. (Ed), Encyclopedia of Policy Studies, New York, Marcel Dekker.

Richards, A.G. (1980), Concepts of Land Information Systems. Seminar on Land Information Systems for Senior Public Servants, Hobart.

Richardson, B. (1992), ERIN – Some Parting Thoughts. ERINYES No.11.

Rideout, T.W., & Holbrook, J.A. (1991), Practical Geographic Information Systems for Conservation and Rural Management. In Rideout T.W. (Ed) Geographical Information Systems and Urban and Rural Planning, Edinburgh. Planning and Environmental Study Group.

Rigby, F.D. (1964), Heuristic Analysis of Decision Making. In Shelley, M.W. and Bryan, G.L. (Eds) Human Judgement and Optimality, New York, John Wiley.

Rittel, H.W., & Webber, M.M. (1973), Dilemmas in a General Theory of Planning. Policy Sciences 4, pp 155–169.

Roberts-Gray, C., & Gray, T. (1983), Implementing Innovations: A Model to Bridge the Gap between Diffusion and Utilization. Knowledge Creation, Diffusion, Utilization, 5, 2, pp 213–232.

Rogers, M.B. (1989), The Application of Land Information Systems in Planning in Western Australia. Proceedings International Conference on Computers in Urban Planning and Urban Management, Hong Kong, August, p 287.

Romer, M.D. (1985), The Changing Relationship Between the User and the Information Processing Specialist. Computers, Environment and Urban Systems, 10, 1, pp 19–21.

Roszak, T. (1986), The Cult of Information, Cambridge, Lutterworth Press

Roy, J.R., & Anderson, M. (1988), Assesing Impacts of Retail Development and Redevelopment. In Newton, P.W., Taylor, M.A., & Sharp, R., Desktop Planning: Microcomputer Applications for Infrastructure and Services Planning and Management; Melbourne, Hargreen.

Rump, P.C., & Hillary, N.M. (1987), Monitoring for Change: Workshop Proceedings, Land Use in Canada Series, 28, Ottawa, Environment Canada.

Sabatier, P. (1987), Knowledge, Policy-Oriented Learning, and Policy Change. Knowledge: Creation, Diffusion, Utilization, 8, 4, pp 649–692.

Sabatier, P. (1988), An Advocacy Coalition Framework of Policy Change and the Role of Policy-Oriented Learning Therein, Policy Sciences, 21, pp 129–168.

Sahal, D. (1977), The Conception of Futures in a Systems Framework. In Linstone, H.A. and Simmonds, W.H.C. (Eds) Future Research New Directions, Reading, Mass., Addison-Wesley.

Schlesinger, A.M. (1963), The Politics of Hope, London, Eyre & Spottiswood.

Schmardt, J., & Katz, J.E. (1986), The Scientific State: A Theory with Hypothesis. Science Technology and Human Values, 11, pp 40–50.

Sedunary, M.E. (1977), The Development and Extension of the South Australian Land Ownership and Tenure System (LOTS). In Proceedings of URPIS 5, Australian Urban and Regional Information Systems Association, Canberra, November, pp 2.1–13.

Sedunary, M.E. (1984), LOTS, the Nodal Approach to a Total Land Information System. In Hamilton, A.C. and McLaughlin, J.D. (Eds) The Decision Maker and Land Information Systems. The Canadian Institute of Surveying, Ottawa.

Sedunary, M.E. (1987), LIS Development in South Australia: 1987 Report. In Proceedings of URPIS 15. Australian Urban and Regional Information System Association, Hobart, December., pp 4.3–6

Shepard, R.N. (1964), On Subjectively Optimum Selection Among Multiattribute Alternatives. In Shelley, M.W. and Bryan, G.L. (Eds) Human Judgement and Optimality, New York, John Wiley.

Shera, J.H. (1983), Librianship and Information Science. In Machlup, F. and Mansfield, U. (Eds) The Study of Information, New York, Wiley & Sons.

Silverman, B.G. (1985), Expert Intuition and Ill-Structured Problem Solving. IEEE Transactions on Engineering Managment, EM22,1, pp 29–33.

Simon, H.A. (1976), Administrative Behaviour. New York, Free Press, 3rd Edition.

Simon, H.A. (1977), The New Science of Management Decision Making, Englewoods Cliff, N.J., Prentice Hall.

Simon, H.A. (1983), Reason in Human Affairs. Oxford, Basil Blackwell.

Simpson, P. (1987), The Flinders Ranges Management Review: A case study in interactive data base and policy development. In, Proceedings of URPIS 15, Australasian Urban and Regional Information Systems Association, Hobart, December, pp 4.2–1.

Simpson, S.R. (1976), Land Law and Registration, Cambridge, Cambridge University Press.

Skjei, S.S. (1973), Information for Collective Action. Lexington, Lexington Books.

Smith, J.L., Mackenzie, H.G., & Stanton, R.B. (1988), Knowledge Based Decision Support for Environmental Planning, Proceedings Third International Symposium on Spatial Data Handling, Sydney, Australia, pp 307–320.

Smith, R.A., & Wellar, B. (1992), A Progresss Report on Public Policy Objectives Achieved Through IS/GIS/LIS . Proceedings of the 1992 Annual Conference of the Urban and Regional Information Systems Association, Vol. V, pp 117–144.

Smith, R.P. (1990), Conflict Management in Victoria. June. Unpublished talk.

Sowell, T. (1980), Knowledge and Decisions, New York, Basic Books.

State Coordination Council Victoria (1979), Report of the Special Task Group on Computer Based Land Information Systems, Vols 1,2.

State Land Information Council (1986), The Conceptual and Technological Strategy for the New South Wales Land Information System. Sydney, NSW Department of Lands.

Steger, W., & Bannister, W. (1992), Information Systems Inputs to Policies. Proceedings of the 1992 Annual Conference of the Urban and Regional Information Systems Association, Washington, Vol. V, pp 106–116.

Teitz, M.B. (1985), Rationality in Planning and the Search for Community. In Breheny, M.J. and Hooper, A.J. Rationality in Planning, London, Pion.

Tichy, N.M. (1982), Managing Change Strategically: The Technical, Political and Cultural Keys. Organizational Dynamics, Autumn, pp 59–80.

Topping, K. (1993), Relevance of GIS to Policy Remains Most Important Test, URISA News, 131, March, p 1.

Toulmin, S. (1958), The Uses of Argument. Cambridge, Cambridge University Press.

Tversky, A., & Kahneman, D. (1981), The Framing of Decisions and the Psychology of Choice. Science, 211, pp 453–458.

Ulen, T.J. (1990), The Theory of Rational Choice, Its Shortcomings, and the Implication for Public Policy Decision Making. Knowledge: Creation, Diffusion, Utilization, 12, 2, pp 170–198.

Vickers, G. (1987) Policymaking, Communication and Social Learning. New Brunswick NJ, Transaction Inc.

Von Foerster, H. (1977), The Curious Behaviour of Complex Systems: Lessons for Biology. In Linstone, H.A. and Simmonds, W.H.C. (Eds) Future Research New Directions, Reading, Mass., Addison-Wesley.

Waddington, C.H. (1970), The Importance of Biological Ways of Thought. In Tiselius, A. and Nilsson, S. (eds), The Place of Value in a World of Facts, New York, John Wiley & Sons.

Walker, P.A., & Moore, D.M. (1988), SIMPLE: An Inductive modelling and mapping tool for spatially-oriented data. International Journal of Geographic Information Systems 2, 4, pp 347–364.

Wallner, H. (1976), The Land Data Bank of Sweden. In Simpson, Land Law and Registration, Cambridge, Cambridge University Press.

Walsh, S.D., & McQuoid, R.M. (1991), The Resource Management Process in New Zealand and Its Indications for Land Information Systems. Proceedings of AURISA 91, Australasian Urban and Regional Information Systems Association, Wellington, pp 34–44.

Watkins, P.R. (1982), Perceived Information Structure Implications for Decision Support System Design. Decision Sciences, 13, 1, pp 39–59.

Watkins, P.R. (1984), Preference Mapping of Perceived Information Structure: Implications for Decision Support Systems Design. Decision Sciences, 15, 1, pp 92–106.

Weaver, C., Jessop, J., & Das, V. (1985), Rationality in the Public Interest: Notes Toward a New Synthesis. In Breheny, M.J. and Hooper, A.J. Rationality in Planning, London, Pion.

Webber, D.J. (1983), Obstacles to the Utilization of Systematic Policy Analysis. Knowledge.: Creation, Diffusion, Utilization, 4, 4, pp 534–560.

Weber, M. (1958), From Max Weber edited by H. Garth, C.W. Mills, Oxford University Press, New York. (Quoted in Forester, J. (1985).)

Weir, C.H. (1984), Introduction. In Hamilton, A.C. and McLaughlin, J.D. (Eds) The Decision Maker and Land Information Systems. The Canadian Institute of Surveying, Ottawa.

Weisband, S.P. (1985), Rational and Symbolic Aspects of Introducing Computing: The Case of an Executive Information System. Committee on Social Science Research in Computing, Working Paper Series, Carnegie-Mellon University.

Weiss, C.H. (1975), Evaluation Research in the Political Context. In Struening, E.L. and Guttentag, M., Handbook of Evaluation Research, Beverley Hills, Sage, pp 13–26.

Weiss, C.H. (1977), Introduction. In Weiss, C.H., Using Social Research in Public Policy Making, Lexington M.A., Lexington Books.

Weiss, C.H. (1980), Knowledge Gap and Decision Accretion. Knowledge: Creation, Difusion, Utilization, 1, 3, pp 381–404.

Weiss, C.H. (1986), The many meanings of Research Utilisation. In Bulmer, M. (Ed) Social Science and Social Policy, London, Allen and Unwin.

Weiss, C.H., & Bucuvalas, M.J. (1980) Social Science Research and Decision Making. New York: Columbia University Press.

Weiss, J.A., & Gruber, J.E. (1984), Using Knowledge for Control in Fragmented Policy Arenas. Journal of Policy Analysis and Management, 3, 2, pp 225–247.

Wellar, B.S. (1983), System and Services in an Information Society: Implications for Local Governments and their Communities. In Proceedings of URPIS 11, Australian Urban and Regional Information Systems Association, Brisbane, November, pp 4.1–9.

Wellar, B.S. (1988), Incorporating the Policy Dimension in Local Government Information Systems: Getting our Priorities Right. In Papers from 1988 Annual Conference of the Urban and Regional Information Systems Association, Los Angeles, August. Vol.IV: 142–152.

Wellar, B. (1990), Editorial. Computers, Environment and Urban Systems, 14, 1, pp 1–4.

Wellar, B. & Harris, B. (1992), Information and Knowledge Bases for Decision-Making: A Progress Report. Proceedings of the 1992 Annual Conference of the Urban and Regional Information Systems Association, Vol. V, pp 85–105.

Wengert, N. (1983), Land Use Policy. In Nagel, S.S. (Ed) Encyclopedia of Policy Studies, New York, Marcel Dekker, pp 647–665.

Wenk, E. (1979), Political Limits in Steering Technology: Pathologies of the Short Run. Technology in Society, 1, pp 27–36.

Wesche, J. (1986), The Crown Lands Study – An Overview. Proceedings of URPIS 14, Australian Urban and Regional Information Systems Association, Melbourne, November, pp 174–178.

Western, J.S. , & Wilson, P.R. (1977), Planning in Turbulent Environments. St. Lucia, University of Queensland Press.

White, L. (1974), Technological Assessment from the Stance of a Medieval History. Technological Forecasting and Social Change, 6, pp 359–369.

Wilensky, H.L. (1967), Organizational Intelligence, New York, Basic Books.

Wingrad, T., & Flores, F. (1986), Understanding Computers and Cognition: A New Foundation for Design, New Jersey, Ablex Publishing.

Winner, L. (1977), Autonomous Technology, Camb., Mass., MIT Press.

Witzling, L.P. (1976), Information Gathering Behaviour and Spatial Planning Problems. Ph.D. Thesis, Cornell University, Unpublished.

Worrall, L. (1989), Urban Planning Processes and Strategic Information Systems. Proceedings International Conference on Computers in Urban Planning and Urban Management, Hong Kong, August, pp 123–134.

Zaltman, G. and Duncan, R. (1977), Strategies for Planned Change, New York, Wiley.

Zeigler, H. (1980), Interest Groups and Public Policy: A Comparative, Revisionist's Perspective. In Scott, R. (Ed) Interest Groups and Public Policy, Melbourne, Macmillan.

Zwart, P.R. (1975), Towards More Systematic Design of Surveying Courses, The Australian Surveyor, 27, 1, pp 22–28.

Zwart, P.R. (1981), Administrative Reform for Land Information Systems A Necessity. Proceedings of URPIS 9, Australian Urban and Regional Information Systems Association, Geelong, no pagination.

Zwart, P.R. (1984), The Rise and Decline of Land Information Systems, International Cartographic Conference, Perth, pp 123–133.

Zwart, P.R. (1984b), Decision Making, Land Information Systems and Microcomputers, Some Experiences and Suggestions. In Hamilton, A.C. and McLaughlin, J.D. (Eds) The Decision Maker and Land Information Systems, Ottawa, Canadian Institute of Surveyors, pp 338–347.

Zwart, P.R. (1986), User Requirements in Land Information System Design Some Research Issues. Surveying and Mapping, 46, 2, pp 123–130.

Zwart, P.R. (1986b), The Production of Information for Policy Decisions from Land Information Systems. Invited Paper, Commission 3 XVIII FIG Conference, Toronto, June, pp 322–331.

Zwart, P.R. (1986c), Surveying Courses – Conceptual Shortcomings and Some Remedies. The Canadian Surveyor, 40, 1, pp 29–37.

Zwart, P.R. (1986d), Better Information for Better Decision Making: Fact, Fiction or Maybe. Proceedings of URPIS 14, Australian Urban and Regional Information Systems Association, Melbourne, pp 38–46.

Zwart, P.R., (1989), Education and Training for End-Users of Land Information Systems, Invited Paper UN Inter Regional Seminar on Land Information Management and the Developing World, Adelaide, January, p 15.

Zwart, P.R. (1991), Some Indicators to Measure the Impact of Land Information Systems in Decision Making. In Proceedings of the 1991 Annual Conference of the Urban and Regional Information Systems Association, San Francisco, August, Vol IV, pp.77–89.

Zwart, P.R. (1991b), Development of Spatial Information Standards. Search, Vol.22, No.2, pp.55–57.

Zwart, P. (1991c), Education and Training for Land Information Management Its Changing Nature. In Masters E.G. and Pollard, J.G. (Eds) Land Information Management, UNSW Monograph 14, pp.259–269.

Zwart, P.R. (1992), Mature GIS – or Taking G out of GIS. SIRC 92 Conference, Spatial Information Research Centre, Otago, New Zealand, pp

Zwart, P.R., & W.R. Love (1983), Some Aspects of Data Base Schema for Land Information Systems. Proceedings of URPIS 11, Australian Urban and Regional Information Systems Association, Brisbane, pp 3A13–22.

APPENDIX A1

DATA, INFORMATION, KNOWLEDGE – A FOCUS

Data, data everywhere and not a thought to think.

[Shera 1984:384].

Through common and mostly uncritical usage, the distinctions between the words *data*, *information* and *knowledge* have become blurred. To some, the words within the sets data-information, and information-knowledge are nearly synonymous, to others quite distinct. Each discipline tends to link its "culture", its conventions and nuances of meaning, to the terms in such a way that they attain properties, functions, dimensions and interrelationships unique to that discipline and hidden from most others. Consequently, as Glazer [1983:59] notes, these unstated semantic and value differences assigned to each term by individual disciplines may seriously impede the utilisation of information. Thus, the clarification of the terms are of some importance – as Mortazavian [1983:593] says, "One thing is certain from the literature: there is no consensus, no clarity, but plenty of confusion".

Information

The pivotal term is *information*, not only because it is the subject of this study, but also because it may be defined by, and in turn be used to define, the other two terms. For instance, the Oxford English Dictionary defines *data* as "facts or information", while *information* may be defined as "knowledge communicated by others or obtained by personal study or investigation" (Webster's Dictionary). The original meaning of *information* stems from the verb "to inform" meaning "to form (the mind, character) especially by imparting, learning or instruction" (Oxford English Dictionary). Machlup and Mansfield [1983:642] therefore argue that any meanings of *information* other than (i) the telling of something, or (ii) that which is being told, are either analogies or metaphors or a result of limiting the definition of the word.

Definitions of information such as "the removal of uncertainty" offered by Kochen [1975:5] are in Machlup's view just limiting the telling to something previously known with less confidence. These types of definition, however, abound; for example, information has been defined as a validation or verification of facts or ideas [Inkles 1975:1973, Sowell 1980:25], or as organised data of use and value [Palmer 1984:10], or as the act or process by which knowledge (or a signal, message) is transmitted [Machlup 1980:8].

The first of these definitions is essentially a rephrasing of the uncertainty criterion, while such terms as "useless information" would tend to indicate that value or utility is not a good definitional criterion. The most widely accepted definition of information is the last mentioned – information as the act of informing. What the process of information is transmitting or to whom it is directed is not important, only the act matters.

The process of informing is normally designed to achieve, but does not necessarily bring about, a change in the object, entity, or person being informed. Information may therefore be defined as "that which determines form (of the receiver, object, etc.)" [Mackay 1983:486]. Usually the desired form is a particular state of knowing in someone's mind. Information may therefore be viewed as the activity by which knowledge is changed; to know is the result of having been informed. Information is thus a process, knowledge a state [Machlup & Mansfield 1983:644]. However, in the ordinary sense of the word as defined by the Webster's Dictionary (above), all information is knowledge.

Knowledge

Knowledge is that which is known, be it as a stock of facts, values and experiences [Boulding 1983:549] or as "... knowledge proper, insight and understanding, and judgement" [Lohuizen 1986] to which infomation adds. In the process of adding, the information may restructure, change or otherwise modify the stock of knowledge by engendering the cognitive processes of assimilation and accommodation [Piaget 1970:709], where assimilation integrates the input into the existing cognitive structure and "accommodation" describes the modification of the structure by the elements assimilated. Before assimilation and accommodation (i.e. learning) can take place, both the message (data) and the existing knowledge structure have to fulfil certain conditions [Ausubel 1978, Zwart 1986] if the information is to have meaning, i.e. fit in with the existing knowledge stock. The preferred arrangement of information as a descending hierarchy of gradually more and more specific messages (concepts) in cognitive and behavioural terms closely resembles the information requirements for the intelligence, design and choice activities of the decision making process [Simon 1977:3]. This is perhaps not surprising, as most decision models are largely empirical, derived by observing and modelling actual decision making processes [Janis & Mann 1977:171].

One other aspect of knowledge should also be noted. Neither meaning nor knowledge needs action or information to be generated. Cognitive meaning depends upon the state of knowledge, while from a behavioural view meaning depends on the association of gestures and symbols with particular acts [Buckley 1983:603]. New knowledge can be generated by restructuring existing knowledge through rethinking without the receipt of any new information [Machlup 1983:644]. This leads to the idea of knowledge as processed or structured information: i.e. information elements put into a meaningful structure [van Lohuizen 1986]. Acquiring meaning and knowledge through restructuring may therefore be independent of any act of informing.

To conclude this discussion of knowledge, it is not necessarily assumed that information is correct or knowledge true [Weiss & Grueber 1984]. Ideas, unlike observed facts (information), need to be authenticated to produce "true" knowledge. The process of authentication or verification is as important as having the information itself [Sowell 1980:4], because it may take considerable resources and time to produce clear, timely, reliable, valid and adequate knowledge [Wilensky 1967:viii]. Ideas which pass a systematic authentication process may be considered facts, while those which fail are falsehoods. Intermediate states in the authentication process produce theories, visions, illusions and myths, but at some stage the probability of a mistaken conclusion is reduced to where we say we know "this or that". It is for this reason that definitions like those proposed by Glaser refer to knowledge as facts or truths, or as "... (4) an item of information that a person certifies as valid by applying one or more criteria or tests, and (5) the findings of validated research" [1983:2]. But as Pfiffner notes, a person may have limited opportunities to verify information; may have more than one interpretation, and may screen (or attest) information "through a mesh of conflicting considerations, personal investigation, and his professional knowledge and experience" [1960:129]. A similar disparity may occur over time: that which once was a truth may yet turn out to be a falsehood or a belief [Machlup 1980:117].

Data

To complete the trilogy, data are anything (number, books, electrical impulses, assumptions, etc.) given. They represent purposeful symbolic surrogates of an observed reality within the context of formal rules and form [Bedard 1986]. They are part of an abstraction of the real world in which certain features (within a particular context and by some particular criteria) are emphasised and the remainder discarded. Where data are obtained by observing this defined reality, and hence capable of replication, they are typically referred to as "hard" or scientific data. As such they are factual propositions or statements about the world, and they may be tested "to determine whether they are true or false – whether what they say about the world actually occurs, or whether it does not" [Simon 1977:46]. Soft data, on the other hand, exists when the data are inferred or where assumptions must be made in order to collect them [MacMullin & Taylor 1984]. Yet, both hard and soft facts "are relevant only in relation to some judgement of value and judgements of value are operative only in relation to some configuration of facts" [Vickers 1965:40].

In a narrower sense, and more apposite to this study, data are what is given to a computer operator for data entry, whether it is a list of population statistics or the manuscript of an encyclopedia. It may not, however, be data in any other sense or context. As information scientists still disagree on whether various degrees of processing transform data to information, it is proposed to follow Machlup and Mansfield's [1983:648] suggestion that in this case the name does not make any difference for any reasonable purpose. Both the terms *data* and *information* are employed when referring to information (data) stored in digital computers.

Summary

Taking *data* to be that which is given, *information* as the process of informing and *knowledge* as that which is known, land information should perhaps be more correctly termed *land data systems* (as many were in the 1960s and 70s), and should be referred to as land information systems only if in fact they succeed in informing, either instrumentally or conceptually, their intended recipients about the characteristics and qualities of the intended reality, i.e. land and its characteristics. This study could therefore be viewed as an attempt to ascertain whether these systems are worthy of their name when it comes to public decision making about land!

APPENDIX A2

RATIONALITY

The land information systems literature in general takes it for granted that the information supplied by a land information system will feed and nurture the rational, cause-and-effect, means–end decision making process described by the scientific model of rationality. This process implies the systematic identification of alternative courses of action and the selection of those most likely to achieve the given goal.

There is, however, no general consensus on what is encompassed by the term *rational*, or its context [e.g. Hill 1985], but most of its definitions contain the notion of a selected action producing, as best it can, a desired outcome. Thus Reade [1985:77] states that "a rational act, in the social sciences, is understood as one which the actor has reason to believe will best or most efficiently produce the consequences which he seeks." Rationality in planning, according to Harris [1985:60], "is a part of a self-conscious instructive social process seeking to find actions which promote the maximal future attainment of the society's objectives." Rational procedures were introduced into the planning process both to create a rigorous understanding of problems and to provide a means by which optimal decisions could be "logically deduced from such an understanding" [Breheny 1984]. In each case what is involved are the ideas of a means to an end, a best solution, a rigorous, scientifically reasoned process producing optimal or true answers.

Functional rationality, or the efficient relation of means to a given end, is generally thought of in relation to positive knowledge and abstract reasoning applied objectively to the external world. In its purest form, once the end to be achieved is given, the aim becomes to optimise the solution, irrespective of the acceptance or morality of the given end. But as Forester [1985:52] notes, rational action inherits a historical starting point, a context "in which information and misinformation, help and hindrance, support and opposition, are all likely to be forthcoming."

In a more reflective mood, therefore, it is also recognised that human reasoning is influenced by social conditions and their resultant assumptions and beliefs, requiring the exercise of substantive rationality. While there is considerable debate about what is meant by substantive rationality – "altogether too vague"

[Reader 1985:86] – the necessity for a concept to modify the clinical impartiality of the scientific method in a social context rests on a number of grounds and is widely accepted.

> In the first instance, it should be perfectly clear that the ends–means dichotomy is not and cannot be complete. Means which are selected have intrinsic as well as extrinsic qualities and carry some of the burden of morality which is always involved in social action. At the same time, the ends which are sometimes supposed to have been given outside of the rational decision making process have extrinsic effects which affect the fulfilment of their own and other values.
>
> [Harris 1985:61]

This is analogous to the distinction that Clapp et al. [1985] make between their classification of programme effectiveness and contribution to well-being. The first measures the effectiveness with which the information is employed, irrespective of the righteousness of the goal to be achieved in the decision making process; and the second is "the contribution of the system to the well-being of society of a whole. ... In this regard, efforts must be directed toward the effects that the land information system has upon such broad goals as individual integrity, social justice, distribution of wealth, and fulfilment of human aspirations."

It is also functional or technical rationality as distinct from substantive rationality which dominates the land information system concept, though the importance of the latter has been stressed in recent years, if only in somewhat different terminology [Niemann 1987, McLaughlin 1982].

<u>Functional Rationality</u>

Functional rationality has three main characteristics: the pre-existence of purpose, the necessity of consistency, and the primacy of reason. It is therefore founded on the belief that behaviour can only be interpreted intelligently against some predefined yardstick (a goal or aim); that actions and beliefs should be consistent over time, achieved by adhering to objectivity and truth, and that correct rational behaviour is measured by systematically relating consequences to objectives through the application of reason.

A functionally rational process takes the goals as given. Hence, as these goals are outside the rational process, they cannot be established through rational means as claimed by Reade [1985:80]. Logically the selection of the goals to be pursued is thus a non-rational-substantive process. But as Webber quoted by Forester [1985:50] observed, the scientific or critical attitude cannot be systematically justified on its own standards, for ultimately science rests on society's irrational moral and ethical acceptance.

> Nevertheless science, in the name of "intellectual integrity" has come forward with the claim of representing the only possible form of reasoned view of the world. The intellectual, like all culture values, has created an aristocracy based on the possession of rational culture and independent of all personal ethical qualities of man. The aristocracy of intellect is hence an unbrotherly aristocracy.
>
> [Webber 1958:355]

It is this intellectual, objective component that is often highlighted in the land information systems literature, as for instance in the earlier quotations from Weir [1984] and Epstein [1988]. This emphasis on objectivity and reasoned choice after rigorous examination of alternatives is in line with the notion that science is truth, is good; that rational methods "bring the prowess of 'truth' to identification and establishment of a common good" [Weaver et al. 1985:145]. To attain this objectivity, as Goldberg [1985:122] notes, the observer has to be separated from the object under study: i.e. the observer needs to be independent and value-less. To quote Churchman [1968:86]:

> One of the most absurd myths of the social sciences is the "objectivity" that is alleged to occur in the relation between the scientist-as-observer and the people he observes. He really thinks he can stand apart and objectively observe how people behave, what their attitudes are, how they think, how they decide.

Since data is substituted for the observer in a land information system, if a rational process is to be followed the data contained in the system would have to be benign, free of an agreed bias. This notion of value-free data has been a long-standing tenet of land information systems [e.g. Niemann 1987]. The avoidance of random bias through the promulgation of classification standards and quality control are a central and current issue [e.g. AURISA 1985, ALIC 1990]. Yet, as many observers have noted [e.g. Bruner 1969:117, Harris 1985:61], data is not, and cannot be, benign "because the values are diffused through all the strata of the various sciences" [Koestler 1969:223]. All the same, the separation of facts and values, like the means from ends, is a dominant tradition of Western culture, of which land information systems are but a small component.

Also part of the same Western tradition is the belief that knowledge is to be sought through rational analysis and introspection, a belief in the power of reason as opposed to faith or religion, coupled with a conviction that reason "should become the fundamental criterion for the solution of problems" [Teitz 1985:139]. People have faith that reasoned arguments, analysis and choice will bring about a solution; will control the problems they see about them every day. What historically is the cult of the rational has been continually challenged by those who assert that there is something more than the rationalistic order – custom, language and tradition, for example. In present day society, however, rationality is the prevailing faith, to the exclusion of most others.

> Both within the theory and within the culture we insist on the ethic of rationality. We justify individual and organisation action in terms of an analysis of means and ends. Impulse, intuition, faith and tradition are outside that system and viewed as antithetical to it. Faith may be seen as a possible source of values. Intuition may be seen as a possible source of ideas for better alternatives. But the analysis and justification of action lie within the context of reason.
>
> [March 1971:573]

From a functional or technical point of view, whether the decision making process is rational or not is unimportant for this study. Narrowly, what is important is that the information emanating from a land information system has been used in making the decision, be that through scientific reasoning, dialectic negotiation or collective bargaining. That these other "irrational" processes are legitimate, or even exist, plus the fact that they are also knowledge- and information-based, has received scant attention from the land information systems community.

Substantive Rationality

Though the notion of functional rationality is intellectually appealing, in practice facts cannot be absolutely separated from values, total objectivity is unattainable, scientific rationality cannot be divorced from the society that supports it, and goals are rarely given but need to be determined as an integral part of the decision making process. As Goldberg [1985:128] points out, the learning of analytical techniques in the absence of subjective as opposed to objective applications is unlikely to lead to very useful knowledge. Further, such analytically objective rational knowledge may in fact be quite irrational in itself in an action-oriented situation.

A concept of substantive rationality recognises these blemishes, and permits of values and ethical considerations, recognising for example "that religion and its associated ethical system represents a social reaction towards the irrational component of human nature", thereby acting as a control or constraint on rational zealots [Harris 1985:64]. Hence as Weaver [1985:149] observes, the contemporary quest for a new rationality and a new science, away from purely functional rationality, has become one of learning to bound and balance the application of knowledge in each concrete situation. He suggests that bounding involves the imposition of limits on the information to be drawn upon to reflect a relevant definition of the problem under consideration, while balancing entails framing a problem in such a way as to ensure appropriate inputs of knowledge and experience. Such a method, he argues, acknowledges personal, subjective experiences and social and historical conditions, as well as objective "realities" these together combining to form "a synthetic reasoning to create holistic, yet multi-dimensional, images." This system makes rationality ethical [Waddington 1969:101] through introducing some minimum amount of value judgement from outside the rational process.

In short, what Weaver proposes is a recognition of the inseparability of fact from values, be they personal, organisational, or ethical; a recognition that other knowledge besides the scientific will legitimately contribute to a decision, and that action takes place within a particular context which constrains the means and the end. These factors have received little recognition in the land information system community.

There is also another view of substantial rationality which states that rationality ought to be so defined as to lead to the rational selection of social values (goals). This view of substantial rationality, however, does not have many supporters. Castberg [1969:152] draws attention to the well-known fact that human appreciations of right and wrong are often in opposition in such a way that renders any search for the objective validity of one over the other hopeless.

> Not only are the ideas of aims and means, of facts and ideals and of the meaning of justice very often fundamentally different. But even when many values are recognised in principle by all parties, these values are, as a general rule, in commensurable quantities. No scientific exploration of social life can answer the question as to which value should have priority in the conflict between for instance economic efficiency against social justice, social security against freedom of speech or between the right of personal liberty against the right of society to protect itself against crime.

Others like Reade [1985:80] and Harris [1985:62] are equally strong in rejecting rational discourse as a means of choosing society's ultimate values or the way in which they should be pursued. This is not to deny, however, that in the end some value may be chosen more or less consciously, either through thought or through a process of dialogue and consensus. It is in this manner that the analytical processes and information in a land information system could assist in the process of formulating societal goals.

The use of land information in helping to form and make value judgements may be looked upon as a pro-active use of a land information system. Equally, if not more so, information may be used in a reactive mode: that is, to justify or support a decision made on the basis of value. In this case, a decision already made has to be "rationalised" [Lasswell 1975:167, Kramer 1981:273], with the information acting as an insurance that the selected decision (value) is "correct" [Annells 1987]. Thus, as Harris [1985:75] observes, even if the proposed solutions are derived by inspiration, be this from personal prejudice or enlightened common good, "rationality permits efforts at the scientific verification of the consequences of the solutions and of their value to society".

APPENDIX A3

INFORMATION AND UNCERTAINTY

TYPES OF UNCERTAINTY

There are basically three kinds of uncertainty in decision-making, stemming from uncertainties traceable to imperfect knowledge of the external environment (physical, social, economic etc.); uncertainties as to the relative future consequences of choices; and uncertainties as to the appropriate value judgements [Brown 1984:87]. Any of these types of uncertainty may arise at any stage during a decision, be it in the problem definition phase when articulating needs and the objectives to be met, in the assessment of the environmental factors constraining alternative solutions, or when selecting a solution, the actions required and its consequences.

Different types of information are required at each stage to eliminate or reduce a different type of uncertainty: "the type of uncertainty that exists in a problem situation determines the type and nature of the information that will be relevant" [Skjei 1973:12]. For instance, information may be required to eliminate technical, political or cultural uncertainty from either or both of the internal and external environment of the decision maker [Tichy 1983].

As reported by Blandin and Brown [1977:114], a growing literature on uncertainty as an environmental dimension indicates that not only does it affect the design, structure and behaviour of organisations, but that

> Individual perception of uncertainty depends partly on the perceived clarity of environmentally related information, and the perceived certainty concerning the nature of cause and effect relationships in the decision environment. Both the dimensions involve a temporal concern.
>
> As decision environments become more complex and dynamic, perceived uncertainty increases.

The resolution of these individual uncertainties varies from person to person with some of us requiring considerable information and assurance before we act while others are far more willing to act on the basis of limited information and substantial uncertainty [Morris 1971:195]. Others again maintain that if the state-of-the-art in a field of knowledge is not sufficiently mature to speak about the risk of this or that action compared to another "then it is an open question whether anything should be said at all" [House 1982:32]. In other words, a totally subjective, non-cognitive assessment of uncertainty and risk may be an equally valid method under the condition of incomplete information and knowledge.

In the extreme, some of those who are uncomfortable with uncertainty may bury it. As one interviewee of Martino and Lenz [1977:385] put it: "Decision makers aren't happy with people who expose uncertainty. They don't want you to expose it. It looks like bad staff work. They won't recognise there are a lot of things you just can't know now."

While this extreme is not very common, there may be a nagging doubt or a low-level sense of uncertainty and concern that the crucial bit of information unavailable at the time of this choice may later make us regret the decision made [Janis & Mann 1977:10]. Regret, however, may only be one consequence of a decision made under uncertainty, others being predictable, quantifiable costs on the one hand and undesirable, but sometimes avoidable, qualitative costs in the form of behaviour modification on the other.

THE COST OF UNCERTAINTY

The essential feature is the reduction of the cost of uncertainty, rather than the amount of uncertainty. The knowledge required to meet the first condition may be quite different in kind and quantity from that necessary to reduce uncertainty itself.

In reasonably well defined problems where the expected utility may be measured in quantifiable units, probabilities may be assigned to the uncertainty costs associated with each alternative outcome. This is much more difficult however, when attempting to make allowance for the deterioration in wisdom, vigour and effectiveness often accompanying decisions shrouded in uncertainty.

Behavioural changes of this kind may also

> produce a bias toward over-conservatism, toward routine ways to solve problems, toward doing nothing. Such a bias limits targets more than even a realistically large discount for uncertainty would require. The benefits experienced by the decision maker are, then, dwarfed by uncertainty.
>
> [Mack 1971:5]

These effects of uncertainty may be awkward to quantify in a meaningful way. Even though they are observable, and may be ameliorated in many instances by additional information, this only applies as long as the cost of perhaps redefining the problem does not exceed the cost of the uncertainty. But as Shepard [1964:263] notes, just collecting more information without improving our combinatorial and synthesising abilities is of little avail.

What is not measurable or predictable is the tendency of uncertainty to cause impacts, particularly in the external environment, other than those of direct concern to the decision. This is particularly notable in environmental administration where the

> tendency to act on the knowns and ignore the unknowns exposes to extraordinary biological risks. A number of interactions (energy states and information) in the ecosystem are myriad, while the human mind is comparatively limited in its informational capacity, which means that in ecological matters, we act with a great deal less information than we need to reduce the average uncertainty or risk.
>
> [Edmunds & Letey 1973:295]

Thus decisions concerning complex systems which are neither closed nor bounded inherently have uncertain outcomes in terms of their likely impacts, probabilities and costs, as they cannot converge to a solution [Batty 1979:34].

REDUCING UNCERTAINTY COSTS

Should the cost of the uncertainties be unacceptable – and this applies particularly if decisions are "irreversible" – steps need to be taken to reduce or divert them. Four possible means of reducing these costs, and their likely impact, are considered.

Cost Reduction through Certainty

The most direct way to reduce uncertainty is to move towards a state of certainty by the addition of knowledge, thereby enhancing the probability of the desired decision outcome being attained. It is assumed that complete knowledge will yield understanding, inherent in which is the concept of prediction. Thus "if one truly understands, one can predict the subsequent course of events" [Miner 1978:63] and thereby eliminate the uncertainties of the future. On the other hand, additional knowledge may also extend the range of choice and hence increase complexity and uncertainty, causing information "overload" and creating controversy through contradictory, but equally authenticated, knowledge or expertise [Simon 1983:97]. Hence, as Schmandt and Katz [1986:43] argue, in the policy domain new knowledge may change the task from making a decision within an apparently stable environment "to one of choosing a larger and fluctuating number of options", thereby increasing the uncertainty both for the policy maker and the public.

Cost Reduction through Efficiency

The alternative of simply "using the information that is readily available – the literature, history and experience, the wisdom and know-how of people" [Mack 1971:217] more efficiently, rather than supplying more information, is the justification for many of the analyses, modelling and decision aid tools in use or in vogue today, including land information systems as mentioned in Chapter 3. This better use of the information at hand does not necessarily depend, however, on improvements in quality of the mechanism for its manipulation. It may also be achieved by changing the decision making process and style by:

(1) "constraints of time and money on what may be usefully attempted";

(2) designing methods to "bring information into rapid use";

(3) shifting the problem "to a jurisdiction of broader based organisations";

(4) combining and interspersing decision and learning; and

(5) improving understanding and communication on the goals, utilities, causality and alternatives [Mack 1971: 213-217].

These changes, while not requiring any additional knowledge or information, may result in their attaining higher utilisation and impact levels.

Cost Reduction through Faith

As the knowledge required to attain certainty in decision making almost always exceeds the knowledge available, there must be faith – or at least hope – to fill in the gaps. The ratio of knowledge to faith may vary enormously from one type of decision to another; from complete knowledge and no faith in a simple choice when goals are clear and expected consequences are quantifiable, to the extreme of near absence of knowledge and near total faith, as in religion. Since faith (or belief) represents one point in the authentication of knowledge scale, the replacement of knowledge by belief to reduce uncertainty in decision making may be viewed as merely a substitution of unproven knowledge for "true" knowledge. The probability of an outcome eventuating obviously rests, among other factors, on the accuracy of the knowledge or belief used.

Cost Reduction through Goal Change

A common method of minimising uncertainty is to alter the required level of achievement or even the goal itself. Good enough – satisficing – decisions rather than optimum outcomes are sought by settling for the first strategy that meets a minimal set of requirements (including a predetermined uncertainty cost) [Simon 1976]. This practice is similar to the sacrificing of efficiency for resilience or the fail-safe strategy for survival in ecological systems [Hollings 1977: 129].

To attempt to seek optimal solutions when the uncertainties are so great as to make optimisation difficult extends the notion of optimisation too far. Hence as Martino and Lenz [1977:385] note, "Analysts should be seeking robust solutions which are comparatively insensitive to uncertainty, rather than narrowly optimal solutions which may be invalidated completely by uncertainty." A penalty for adopting this approach could be the consumption of extra "slack resources" to compensate for the additional residual uncertainty costs remaining after the satisficing decision [March and Simon 1958:126]. Against this, the cost of these slack resources may be recovered, at least in part, by the savings in information gathering and processing as well as in further decision cycles. There is evidence to suggest that this happens in practice [Mintzberg et al. 1976]. Prescriptively, through the efficiency offered, the information resource provided by land information systems would reduce the input of slack resources, as the level of available knowledge would be higher for no additional cost.

A further consequence of being willing to accept sub-optimal decisions can be the slowing down of progress towards an optimal course of action by reducing the decision making process to a succession of incremental satisficing decisions, each narrowing down the range of options considered to those that differ only by a small degree from the existing policies. This "muddling through" reduces uncertainty to a minimum by showing a preference for the sin of "omission" over the sin of "confusion" [Lindblom 1965:146] while at the same time minimising the amount of "new" knowledge required.

Satisficing, or the change of goal from optimal to sub-optimal through the acceptance of perhaps a less efficient or effective outcome, may result in more selectivity and random information use and impacts. Moreover, what information has been selected may be known only to the individual decision-maker.

Cost Reduction through Rules

Uncertainty is, of course, designed to be completely eliminated in routine decisions when rules and regulations codifying problem solving experiences are promulgated to provide a response mechanism to handle frequently reappearing problems. They establish their goals and criteria relevant to each individual instance of the problem situation, and the alternative courses of action which constitute an appropriate response, as well as defining the resources (institutional, personnel and knowledge) necessary for their solution. When new situations for which there are no pre-planned rules arise, mechanisms to deal with these exceptions need to be devised, i.e. to handle the information collection and decision making task necessitated by this new uncertainty [Galbraith 1973:11].

Deviation from the rules, however desirable for the individual, has a tendency to create uncertainty. As Blau [1963:126] comments, while operating rules in principle eliminate discretion and thereby restrain individual conduct, the exercise of discretion also makes the job more stimulating. When discretion in decision making is permitted, it may engender anxiety about the correctness of decisions, leading some to "keep difficult cases on their deck instead of completing them, 'being afraid to make a decision'." The need to exercise judgement as much as a lack of knowledge about future outcomes can create uncertainty.

Prima facie, where the decision process is fully defined no new knowledge will be needed to affect the decision. Additional information therefore will have no contribution or impact, except where the rules may allow for it, e.g. in Environmental Impact Studies.

UNCERTAINTY AND POLITICS

Up to now, uncertainty has been used in the scientific or the decision making sense of a deficiency in the knowledge required to solve/optimise the solution to a problem or come to a rational decision. In a political environment (such as a bureaucracy), uncertainty/risk avoidance takes on quite a different meaning and is expressed in terms of a competitive and/or adversary relationship. Officials worry about

(a) presentation of more up-to-date information by an official from another agency at interdepartmental meetings;

(b) presentation of information which contradicts the policy option most favoured by an upper-level policy maker;

> (c) presentation of information which the policy maker is already familiar with;
>
> (d) presentation of information which puts another department or agency into a more favourable light than the one the bureaucrat represents.
>
> [Rich 1979]

The real political issue, of course, is not so much the quantification of risks, but the decision about who should bear them [Ingram and Mann 1983:714].

These types of concern are closely related to the organisational and political implications of the control of information identified, for example, by Laudon [1974] (Appendix C1) and referred to by Weiss and Gruber [1984], Annells [1987] and Graham [1987] in the context of information as a tool of power and influence – the bureaucratic theory of knowledge use, discussed in Chapter 6.

SUMMARY

Several aspects of uncertainty and information already commented on are of relevance to investigating the impact that land information systems have on decision making.

1. Uncertainty, like the problems it surrounds, is not an absolute quantity, merely the difference between what is known and what needs to be known, with the state of certainty being reached through the acquisition of the missing knowledge. This certainty can only be obtained through a complete state of knowledge and through a completely closed, deterministic decision making process. Since planning is the activity of selecting one preferred future from all others and prophesying that it is not closed or bounded, there will never be sufficient knowledge to attain a state of certainty in planning.

Reducing uncertainty by the substitution of more knowledge is therefore only possible if the goal is defined and all alternatives, all consequences and all actions are fully specified, functionally, temporally, and spatially. Under these functionally rational conditions the utilisation of information from land information systems is maximised.

2. In all cases where certainty cannot be attained through complete knowledge, belief, faith, intuition or the like, has to fulfil the gap vacated by "factual knowledge". But as was noted earlier, the salient difference between facts and falsehoods is that one has been verified by some authentication process, the other not. In land information systems this authentication process consists of verifying whether an item of data or knowledge conforms with or can be equated to some

predetermined standard. Data that does not meet standards, however, is known to enter the system: that is, land information systems contain knowledge of varying degrees of falsehood.

Measures to determine the quality or goodness of fit – i.e. the ratio of belief to verified fact – are being incorporated in a number of systems [e.g. Stranger & Magnum 1980, ALIC 1990] as well as data that has been verified as contextually, rather than absolutely, scientifically true [e.g. Simpson 1987, Ingles & Woods 1987].

Hence the certainty that may be ascribed to a decision because of the addition of information from a land information system may be knowingly or unknowingly less than the ascription warrants. Moreover, the standards imposed may also be inappropriate for the context or purpose in which it is being used. This is presently of some concern to the land information system community.

3. Reducing uncertainty by goal closing through the acceptance of sub-optimal or satisficing outcomes may not, *ipso facto*, alter the information content of the decision. Different information may be necessary for an optimum as opposed to a "good enough" outcome; the quantity and quality of the information may be reduced or increased; the process may become more substantively rational; but the goal, the process, the alternatives and choices will still be based on knowledge at hand and information received, even though how this is utilised may not be the same.

4. Where a decision process is self-contained or closed, as is the aim in routine, administrative information processing, the knowledge required to make a decision choice is complete. Certainty as to which alternative should be selected is obtained without the addition of external information. In terms of making a decision, therefore, land information systems can make no contribution. They may, of course, be the source of the information that feeds the routine process.

5. The impact of an item of information on a decision outcome will depend therefore on the means adopted to reduce any outstanding uncertainty about the decision. In all instances, with the exception of fully defined routine decisions where rules eliminate all uncertainty, knowledge is employed to attempt to bring a greater degree of certainty into the decision making process.

APPENDIX A4

SOME VIEWS ON PROBLEMS

What constitutes a problem is open to a number of interpretations, but implicit in all instances it is the lack of a ready response (like a stimulus) to a question that requires thought before action. Five different ways of considering this lack of response are briefly discussed below.

PROBLEM AS A DIFFICULTY

A problem may be taken simply as a state of difficulty or a set of undesirable conditions or "Human needs, however identified, for which relief is sought" [Jones 1977:15]. Equally, the difficulty could be part of the problem solution, "A state of doubt in the decision maker as to which choice is 'best'" [Ackoff et al. 1962:30]. In each case the sense is of a problem as an objective entity or an empirical phenomenon. The problem definition reduces to defining the situation that brings it about [Dery 1984:22].

PROBLEM AS A DISCREPANCY

The most common description of a problem is that of a discrepancy between what is and what "isn't" and what "ought to be", the difference between where we are and where we would like to be [Rittel & Weber 1973:159]. It may involve getting something one wants while also "giving up none or as little as possible of something one does have" [Ackoff et al. 1962:71]. This focus on problems led Newell and Simon [1972] to conclude that "a person is confronted with a problem when he wants something and does not know immediately what series of actions he can perform to get it" [p. 72]. Or in the terminology of systems "problem solving is concerned with finding paths from initial states to desired states" [p. 828].

Neither the initial nor the desired state, however, needs to be particularly instrumental, for the stimulus may just be "man's curiosity about the meaning of some reality" and the response "the process of attempting to provide the requisite understanding" [Batty 1979:22].

The view that problems represent the difference between two states implies that at least certain information is given prior to, and independently of, the solution, including knowledge about what is desired (goals), and some initial information on alternative solutions. Thus the common, normative rational models of decision making are based on goal formulation, the identification of potential goal achieving alternatives and the selection of one (the best) for action.

However, as Janis and Mann point out, the final choice process (decision) may be an illusion if the alternatives offered for choice are severely limited. In this case the decision maker is reduced to taking "a passive role ... since there seems to be nothing else he can do" [1977:225].

PROBLEMS RELATIVE TO PURPOSE

The two views above take problems as observable situations, as objective entities in their own right. But problems can also be construed as relative to purpose or as analytical constructs of the mind [Dery 1984:25]. For instance, a change of land use zoning permitting the construction of high rise apartments on the fringe of a town to alleviate a critical shortage of student accommodation may present the builder with a finance problem, the future tenant with a transport problem, the local residents with an unanticipated noise problem and a young group of environmentalists with a value problem. Many different kinds of problem for different kinds of people may emerge from the one event. Problems are therefore not the same for all people, whether they are interested or disinterested parties, whether they are engaged on the same tasks and to the same end or not.

These characteristics are typical of public decision making. As a consequence, problems need an environment or context containing "all the factors which can affect the outcome and which are not under the decision maker's control" [Ackoff et al. 1962:31]. They therefore need to be viewed from a multiplicity of perspectives, and from a much broader base than that of the functional rationalist. They also need a context, a problem solving space, as will be discussed below.

An undesirable set of conditions is not in itself a problem but only if we perceive and label it as such, for there can be no problem unless there exists a desire to obtain a yet unattained outcome or state. Hence there is not "a" problem or "the" problem, but a number of individual concepts, none of which is correct or incorrect. Moreover, it is our conception of a situation and how well we relate to it that determines, for example, whether a problem is simple or complex. These things are not a function of any objective attribute inherent in a given situation.

The recognition of the existence of a problem and how we frame the definition is therefore a matter of the knowledge possessed, the information being gained and the context or perspective from which it is all viewed.

PROBLEM AS AN OPPORTUNITY

Lastly, a problem may be considered as an opportunity for improvement [Dery 1984:26]. Although recognising a problem is a function of how we define the problem as well as a question of choice, this choice may be severely limited by constraints (economic, political, organisational, etc.), to a point where a solution may not be feasible nor offer any positive nett benefit. In that case, the problem could, by choice, be deemed insoluble. It may therefore be advantageous to treat problems as chances for improvement rather than as discrepancies between, at the time, two ill-defined states.

SUMMARY

Land information systems are designed to identify and assist in the resolution of, each of these kinds of problem.

Prescriptively, being an inventory of current data about a portion of the earth, the system indicates the "what is" state. If this state is undesirable, then the data in the inventory, either directly, or indirectly through manipulation, analysis and model building, should point to its cause and the desired state. As a land information system aims to be a comprehensive collection of data and knowledge, it should be capable of performing these tasks from a number of perspectives, having respect to a number of different purposes in different contexts.

APPENDIX A5

A GENERAL INFORMATION SYSTEMS-BASED MODEL OF DECISION MAKING

Introduction

When system and procedural methods were *de rigueur,* the policy making, decision making and land information systems were considered to be synonymous processes, based on the same functional rational model. In this rationalist tradition the generalised information system model illustrated in Figure A5.1 could therefore, equally well represent any of this three processes. Ignoring, for the moment, which of these activities is being depicted, each of four modules in the system is seen to be capable of accepting and disseminating information, of storing knowledge and of generating knowledge by manipulation and analysis. Each module may therefore be conceived of as an information system in itself – a sub-system dedicated to fulfilling one operation within the overall information system – like the 'wheels within wheels' in Simon's three phase decision making process.

The first module is an information resource module (IRM) which contains: knowledge obtained from the environment; from previous decisions via information about the results of actions – (from the transformation module); and basic reference data. The results of the problem solving process i.e. the goals to be achieved, alternative methods of satisfying these goals as well as criteria for assessing when these prescribed goals have been satisfied are also contained in the information resource module. Newell and Simon [1972:789] take this information to define the problem solving or decision space. If the problem solving task has not been undertaken, or is incomplete, then this has to be determined in the decision making module.

The information resource module disseminates information to the decision making module (DMM) where it is combined with the knowledge contained in the decision makers memory. What may be held in this memory and the function of the module is important for understanding how information may be used. It will be treated in detail below.

The courses of action disseminated by the decision making module are accepted by the execution module (EM) and the results of the action observed and evaluated by procedures held in memory. Lastly, the transformation model (TM)

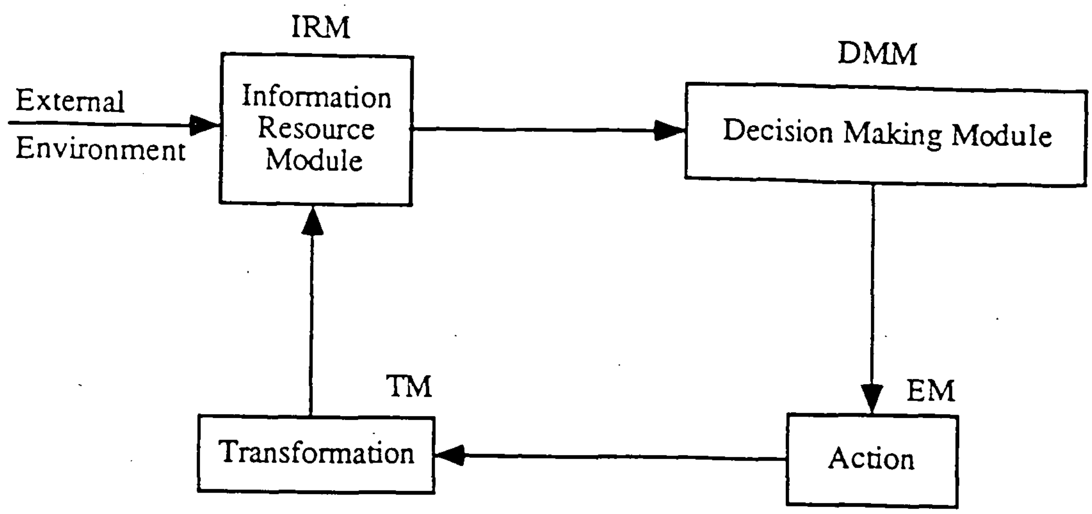


Figure A5.1 A Generalised Information System

changes the observations received from the EM into data ready for entry into the IRM.

Given that the information and knowledge in the system may be made up of facts, or values and beliefs, or goals and objectives, and so on, it may be viewed as a model of decision making process in which the decision maker plays the dominant role because

> ...the decision maker may have stored information about the environment and systems operation and the fact that the decision maker generates courses of action or plans...
>
> [Ernst & Yovits 1972:71].

To understand the interaction between this information and the decision outcome, the operation of the Decision Making Module needs to be examined.

The Decision Making Module

The aim of the decision maker is to regulate the system by ensuring that the Decision Making Module keeps the system in balance given the internal and external constraints of the system. It is possible to achieve this in a number of ways depending on the information and criteria (decision rules) employed. The decision rules (goals, policies etc) may have been defined through a preliminary problem solving exercise or may be a recursive part of the decision making process. In our case, it is assumed that the information external to the module is derived from a land information system. Theoretically, under the conditions of perfect feedback these criteria, and the knowledge held in the Decision Making Module's memory, when applied, should result in actions that bring the system into equilibrium.

In practice however, the system is not perfect. For instance, decisions

> ... may be influenced by a number of factors, many of which have no apparent bearing on the information provided. That is, for all intents and purposes, an independent observer either sees no directly relevant information or may presume that extraneous information has been used in making a decision.
>
> [Ernst & Yovits 1972:72]

This could be due to such factors as the "quality" of the problem solving, how closed or open the decision making actually is [Kast 1968:147] and the amount of "new" or unexpected information that enters the process e.g. "... some side payment extraneous to the original problem or condition" [Lerner 1976:21]. Irrespective of the cause, in the end, it reduces to how the decision maker used the available knowledge to make the decision. If we can understand this, then we may also be closer to understanding the connection between land information systems and the policy and decision making processes.

A Decision Making Model

To investigate some possible relations connecting information, knowledge and decision making the model illustrated in Figure A5.2 will be used. Here, information from the Information Resource Module is selected and transferred to the Decision Making Model where it is held in the store SEI (Selected External Information). This information determines the structure of the decision space and may also define an initial problem programme, stored in memory 2. From here on, the Decision Making Model may be viewed as a self contained, requisite decision model, "requisite in the sense that everything required to solve the problem is either included in the model, or can be simulated within it" [Berkeley & Humphreys 1982:215].

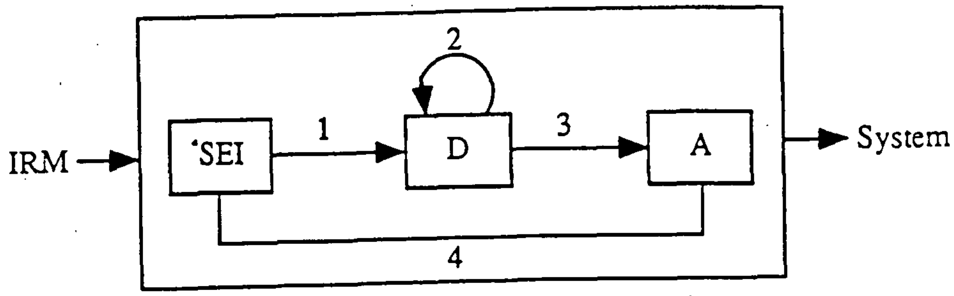


Figure A5.2 Decision Making Module

Memory 2 consists of the decision maker's short-term and long-term memory. Contained within short-term memory are the task instructions including a description of the initial and goal states, possibly an initial problem solving programme and temporary dynamic information about the current solution being processed. In addition there is the knowledge held in long-term memory comprising a combination of: previous experiences with the same or nearly the same tasks; general problem solving "programmes" and methods for constructing problem solving programmes that combine information obtained from the external environment with information already stored in memory.

Numbers 1 and 2 in Figure A5.2 denote the information flows in the problem space from the SEI and in the decision maker's memory respectively. The final or trial decision is internally mapped into a corresponding action (flow 3) which is either tested in the external environment by passing it to the system or is compared with the current task environment (flow 4).

What is of interest is how much of the problems solution depends on flow number 1 or number 2, how much knowledge is contained in the decision space, and how many of its states are derived from the SEI source, that is, from a land information system and how many from the decision makers memory. Clearly, if a decision making process is dominated by the information stored in the SEI, rather than what is in the decision makers memory, then the information is a key element in the process. Hence, for land-based or land-related problems, the potential for land information systems influencing the decision process will be high. Equally, if the decision maker's memory is the dominate influence, that is his experiences, values or beliefs, then the SEI will probably hold little sway in the decision process.

To examine this proposition, first, four differently configured decision making models which vary in how they process information from the SEI, portraying four "recognised" decision processes are examined below. At the conclusions of this examination the operation of each of these models will be compared and analysed to draw some general conclusions how land information systems do, or perhaps could affect the decision process.

Decision Making Model 1 (Figure A5.3)

The assumption in this model is that information in the SEI controls the process with the decision maker confined to choosing between a finite set of fully developed alternatives. All pertinent information has been supplied by the

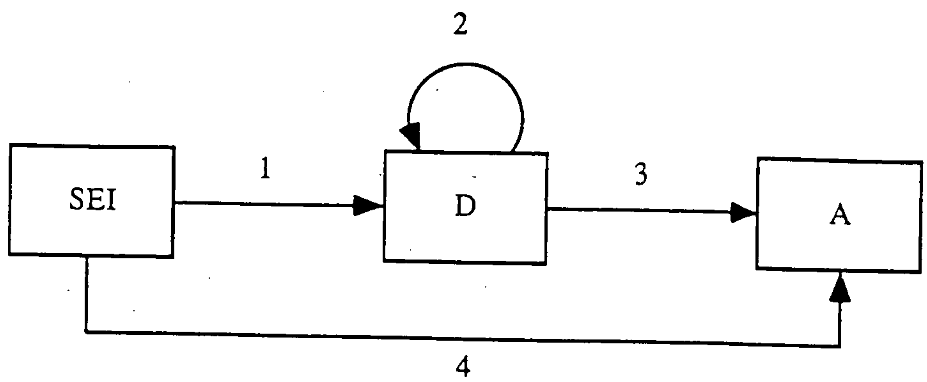


Figure A5.3 Decision Model 1

information resource module, what else may be in the decision makers memory is considered irrelevant, neutral and outside the choice process.

The model represents the classical *homo economicus* or rational view of decision making wherein the decision makers knows both the means and the ends, that is, he has a clearly defined problem, knows the alternatives he can choose from; his preferences for each, and has complete information about the utility of each alternative.

The model is not recursive as all possible sub-goals and sub-problems are known – but neither is it deterministic as a choice exists as to which of the known alternatives to adopt. Thus, the consequences of pursuing alternative courses of action are examined, not the availability of alternatives [Dery 1984:57].

This model is appropriate to describe decision making when the task environment, i.e. the problem definition, and all possible problem solutions are completely delineated, specified, well understood and unique actions are linked directly to a set of input information (arrow number 4). Under different conditions its descriptive value is questionable. For as Mack notes, even assuming the alternative actions are pre-delineated, man's "... perception is selective, not total; [his] aspirations are developmental – they are conditioned by the past and by his image of himself" [1971:9].

Decision Making Model 2 (Figure A5.4)

In this model it is assumed that both the "external" information and the decision makers knowledge are used to make a decision; that the information received through loop 4 is used to update the decision makers knowledge for use in the next decision cycle.

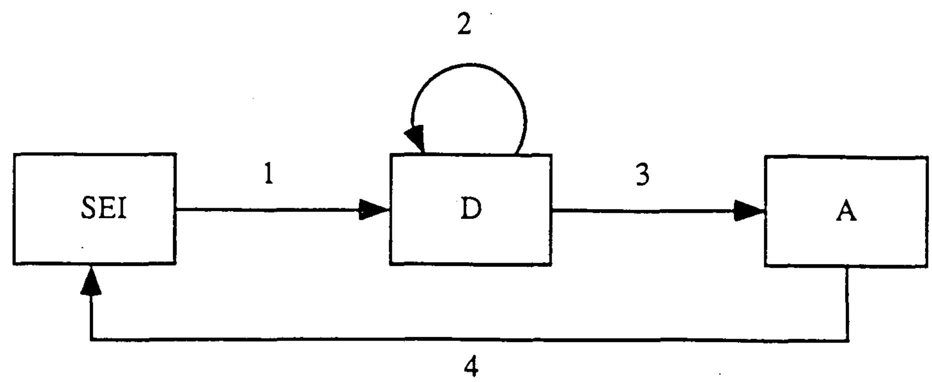


Figure A5.4 Decision Model 2

The model, therefore, is the same case as decision model number 1 with addition of feedback shown by arrow 4 depicting revised information received from the SEI as a consequence of some action. Unlike the previous model, the proposed actions have to be tested against the original decision space as they may not have been identified at the start of the decision cycle.

The model may, therefore, be viewed as an attempt to minimise the cost of uncertainty associated with an action [Mack 1971:149] and answer the main criticism levelled at the limited practicality of the first model by discovering and developing, through a search process, alternative actions and effects. It also permits a revision of the goals, for instance a satisficing rather than optimising solution. By not quantifying the change produced by the decision (action), only the process used, the model, may be viewed as describing, for example, both incremental decision making [Lindblom 1965] and 'mixed scanning' to encompass the "... high order fundamental decisions ... which set basic directions" [Etzioni 1968:7].

Decision Making Model 3 (Figure A5.5)

A special case of the above is the Bayesian model in which the available courses of action are evaluated solely in terms of the initial decision space; hence only the actions are revised, not the state of knowledge of the SEI. It is implicit in Bayesian theory that "... a course of action is rational only relative to a possessed body of information (beliefs and desires) in terms of which the merits of the available courses of action can be rationally evaluated" [Eells 1982:5].

Based on the assumption that probability may be interpreted subjectively (expressed mathematically as "subjective expected utility maximisation theory")

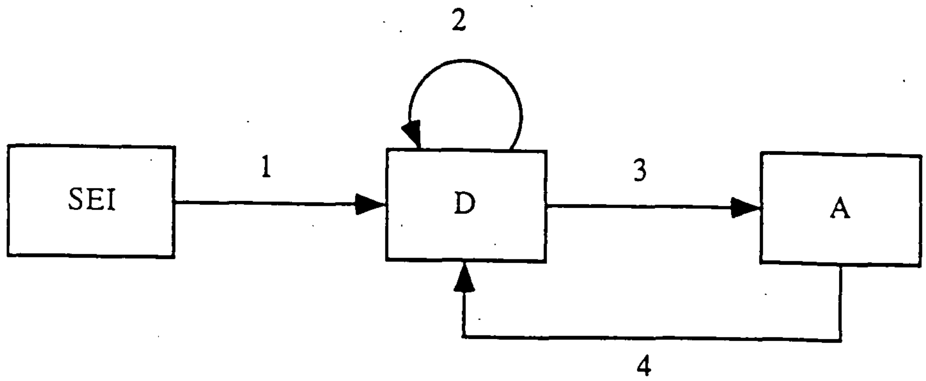


Figure A5.5 Decision Model 3

Bayesian interpretation states that, however poor the information, the best estimate should be made and used to weigh the utility that is expected to be derived from each possible outcome [Mack 1971:34]. It is, therefore, a decision model based on a theory of consistent personal preferences with emphasis on the reasoning and behaviour of the decision maker rather than on the phenomena of the problem environment [Anscombe 1964:156]. Accordingly, it is also a theory about how actions, preferences, values and beliefs must be related to each other – (but not how they should relate to the external, objective world) – in order for them to be rationally related. "Knowledge of the present, the existing reality is [therefore] all important" as the validation of the decision is through the existing reality not through the general goals since they "do not pertain to future knowledge ... *per se* but to more general motivations for understanding the present" [Batty 1979:24]. For this reason, the Bayesian approach is of use as a tool in the problem identification process [Dickey 1972:158] and interpreting the public policy process (Refer to chapter 6).

Decision Making Model 4 (Figure A5.6)

This model represents a non-cognitive decision making process through the operation of heuristics. No longer does the decision space dominate the decision outcome but rather the reference material contained in long-term memory including perceptions, attitudes and beliefs concerning the likelihood of uncertain events stored in the decision maker's memory.

Unfortunately, this knowledge may be incomplete and inappropriate to the task at hand. For it is argued

> that people rely on limited number of heuristic principles by which they reduce the complex tasks of assessing likelihood and predicting values to

> simpler judgmental operations. In general, these heuristics are quite useful, but sometimes they lead to severe and systematic errors.
> [Tversky & Kahneman 1973:1]

They manifest themselves as unknown and unpredicted actions especially in such highly complex systems as the environment [Edmunds & Letey 1973:295]; in decisions that just happen without acknowledged responsibility, purpose or perceived significance [Weiss 1980]; and in "shadow" decisions where there is no apparent link between the information input and the decision output [Ernst & Yovits 1972:72].

Support for heuristic models of decision making stems mainly from research by psychologists and psycho-sociologists on perception and attitude and "... on the failure of a whole tradition of research to fit a normative model of decision making to the behaviour of subjects in even simple laboratory tasks" [Inbar 1979:77]. Heuristic models, therefore, attempt to develop theories to describe the actual, as opposed to the normative operation of the decision maker.

Heuristics, therefore, reflect 'bounded rationality' as they represent "a compromise between the demands of the problem and the capabilities and commitment of the decision maker" [Keen & Morton 1978:66]. In this way for example, they are starting to provide explanations for certain decision making behaviours, notably for incrementalism, through the "notion of familiarity" and for the role of information in judgement [Inbar 1979:85].

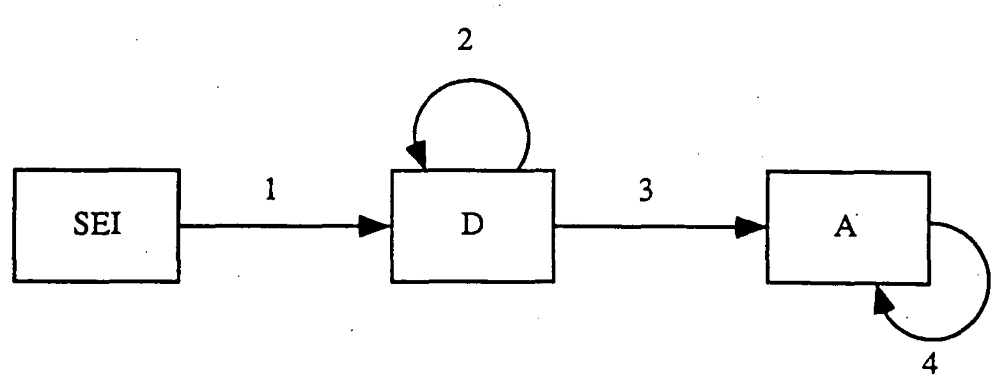
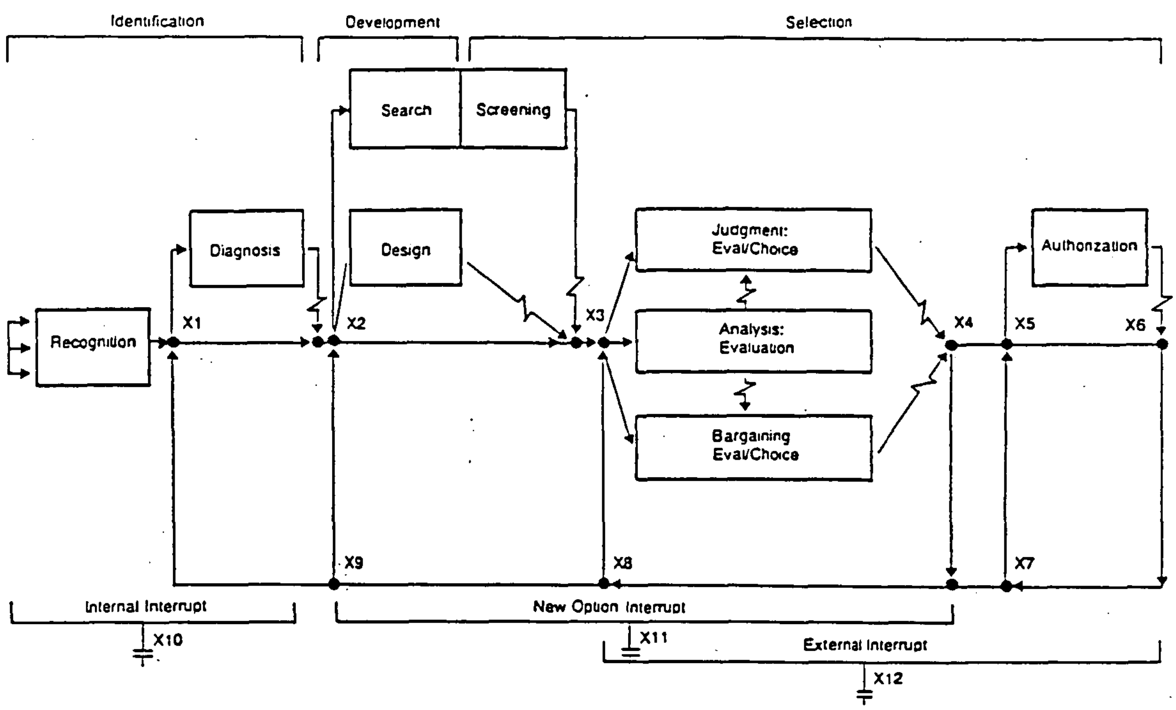


Figure A5.6 Decision Model 4

APPENDIX B

A GENERAL MODEL OF THE STRATEGIC DECISION PROCESS

[Mintzberg, Raisinghani and Theoret, 1976]



The "main line" through the centre of the model shows the two routines that must be a part of any decision process, recognition of the situation and the evaluation-choice of a solution. The three modes of the evaluation-choice program are shown at X3. In theory, therefore, the most basic decision process involves simply the recognising of a given solution and then the evaluation and choice of it. Needless to say, we encountered no case quite that simple.

Most decision processes involve development activity after recognition. Hence, at X2, there is a branch off the main line into the search (and screen) routine to find a ready-made solution or into the design routine to develop a custom-made solution. In virtually all cases, in fact, development was a nested activity; hence, at X4 the model contains a branch from the evaluation-choice routine back to the development phase at X9 to initiate another search or design cycle. Modified solutions, as noted earlier, first follow one or more search cycles to find a ready-made solution, and then a series of design cycles, to modify it. In addition to nested development, nested selection also occurred frequently; hence at X4 and X8 there is a loop from the evaluation-choice routine back to itself.

Any decision process may or may not involve formal diagnosis or authorisation. Hence, the model shows branches at X1 and X5 which take the process off the main line and later return it there when completed. In addition, authorisation may be tiered, hence the loop at X6 and X7, and authorisation to proceed may be sought after recognition or during development, resulting in a branch from the authorisation routine at X6 back to development at X9. And there is evidence that the decision process may branch from selection at X4 or X6 all the way back to diagnosis to allow for reconsideration of the whole decision situation. All of these branches also represent the comprehension cycles for example, cycling within evaluation-choice at X4 and X8 and the failure recycles, from the evaluation-choice routines at X4 or the authorisation routine at X6 back to redevelopment at X9 to modify an unacceptable solution or develop a new one, or back to the evaluation-choice routine at X8 to modify criteria.

Many strategic decision processes involve interrupts of one kind or another. The three most common ones are shown in the model. At X10 are internal or political interrupts in the identification phase, where there is disagreement on the need to make a strategic decision. Such interrupts come from within the organisation and may lead either to cycling in the recognition routine, to resolve the disagreement by bargaining or persuasion, to delays, until the resistance subsides, or to political design activity, to remove the resistance. At X12 are external interrupts during the selection phase, where outside forces block the selection of a fully-developed solution. These interrupts typically lead either to modification in the design to bring it in line with the difficulty encountered, to complete redevelopment of a new solution if necessary, or to bargaining to confront the resistance directly. At X11 are new option interrupts, which typically occur late in development or during the evaluation-choice routine. These lead the process either back to design, to elaborate or modify the new option, or directly to evaluation-choice to select or reject it immediately.

Finally, the model shows an inherent delay, in the form of a broken line, at the end of each of the routines. This reflects the fact that scheduling, feedback, and timing delays separate every step in the strategic decision process. This model does not show the supporting routines, except for bargaining as a mode of selection: but decision control, communication, and political routines can occur together with any of the routines shown in the model.

APPENDIX C1:
Parcel-Based Land Information Systems
PR Zwart
in Newton, P & Taylor, M (Eds), *Microcomputers for Local Government Planning and Management*, Melbourne, Hargreen, 1986, pp.64-76

APPENDIX C2:
The Production of Information for Policy Decisions from Land Information Systems
Peter Zwart
Invited Paper, Commission 3 XVIII FIG Conference, Toronto, 1986, pp. 323-31

APPENDIX C3:
User Requirements in Land Information System Design – Some Research Issues
Peter Zwart
Surveying and Mapping, Vol.46, No.2, 1986, pp.123-130
Reprinted in Dahlberg, R.E., McLaughlin, J.D. & Niemann, B.J. (Eds) 1989, *Developments in Land Information Management*, Washington, Institute for Land Information

APPENDIX C4:
Parcel-Based Land Information Systems in Planning
PR Zwart and IP Williamson
in Newton, PW, Taylor, MAP and Sharpe, R (Eds) *Desktop Planning: Advanced Microcomputer Applications for Physical and Social Infrastructure Planning*, Hargreen, Melbourne, 1987, pp.44-53

APPENDIX C5:
Some Observations on the Real Impact of Integrated Land Information Systems upon Public Decision Making in Australia
Peter Zwart
Invited Paper, *Proceedings of URISA 1988*, Los Angeles, August, Vol.1, pp.68-79

APPENDIX C6:
Embodied GIS – A Concept for GIS Diffusion
Peter R Zwart
in Masser, I. and Onsrud, HJ (Eds), *Diffusion and Use of Geographic Information Technologies*, 1993 Kluwer Academic Publishers, pp. 195-204

7

PARCEL-BASED LAND INFORMATION SYSTEMS

P.R. Zwart

We typically work, live and play on different parcels of land. The use to which the parcel has been put is usually determined by a process involving individuals, community groups and the various levels of government. Each of the parcels may be either privately or publicly owned under a variety of tenure agreements. The economic worth of each will depend on the activities that take place upon it, and will also reflect its natural qualities, improvements, location and relationship to other parcels of land.

Governments, to perform their statutory functions, need to collect, maintain and exchange large sets of information relating to land, its distribution and use. The smallest commonly used subdivision of land, the legal or rateable land parcel, forms the basic spatial unit for administration at the local government level and serves as the object of many management and policy decisions by State governments. Large amounts of information are thus attached to, or capable of being referenced to, this unit of land.

Unfortunately the present organization of the information causes functional biases, difficulties in data interchange (both spatially and temporally), inconsistencies, and the dispersion of data across recording systems both within and across authorities. Changing social demands for accountability in operational and planning decisions, coupled with increasing rates of change within an increasingly complex institutional and social framework, make it necessary to reform existing record systems to provide information systems capable of delivering rapid, precise and reasoned responses: 'While land information forms the "bread and butter" of parts of each organization it is increasingly needed as a tool for broader use, capable of benefiting the community as a whole' (Johnston 1983).

The purpose of this chapter is to describe the elements of parcel-based systems designed to serve these functions, their operation and implementation. Systems of this type are not predicated upon any particular class of computer and thus have been implemented on microcomputers. Such implementation will be discussed in the section headed 'Roles of Microcomputers'. The more general issues of importance to microcomputer-based systems will be noted throughout the chapter.

DEFINITION OF PARCEL

It is unfortunate that even at this early stage in the development of parcel-based information systems there are a number of differing types of parcels being used. The most common of these is the legal land parcel defined as the smallest unit of land which may be separately conveyed. This is the smallest, legally recognized subdivision of land and thus potentially provides the highest density of discrete areal units to which information may be attached. Importantly, unlike most other land parcel units, it is widely used and because of this it has become divorced from any one particular function.

In the majority of instances there is a one-to-one correspondence between the legal and next most common unit, the rateable or valuation parcel. However, when contiguous land parcels are under one owner the valuation parcel may consist of two or more legal parcels. This accounts for about 15 per cent of cases in Tasmania's Valtax System (VALTAX 1984). A number of large systems like the combined Valuer-Generals/ Sydney Metropolitan Water Board systems (Wilkinson 1980) have been developed using the valuation parcel as the basic spatial entity.

The primary functions of these systems is to serve the information needs of valuers. Data are therefore collected, maintained and organized to this end even though the system may contain data types applicable to other users. But, unless data are organized from their inception to accommodate other user requirements and spatial entities, it becomes technically difficult at a later date to incorporate into the system information based on other spatial units destined to serve a wide user community (Collier 1983). As Hodgkinson (1984) has put it:

> Although all of these systems meet the particular needs of the organization concerned ... the information is not readily accessible or interchangeable. Overall, the land information being recorded is not sufficiently comprehensive or accessible to meet the needs of the Government and the community.

Central to parcel-based land information systems is the concept of a common shared resource of information, benign and independent of any particular function or application. The use of arbitrary, functionally dependent spatial units larger than the legal parcel compromises this concept by making it difficult to interchange data and by reducing data integrity through the need to aggregate and generalize data sets. Established procedures precisely define and maintain the physical extent of the legal parcel. This, together with its wide acceptance, has led the majority of property-based information systems throughout the world to opt for the legal parcel as the basic spatial referencing unit. Its adoption for local government purposes is recommended and is assumed *a priori* in this chapter.

WHY PARCEL-BASED SYSTEMS?

There are large repositories of information pertaining to land being maintained and utilized by all levels of government as a basis on which to make operational and planning decisions effecting distribution and use of land within the community. This information may be broadly classified as indicated in Table 7.1. The vast majority of this information is either a description of a characteristic of the land parcel or additional elements to be referenced to it for some functional purpose. By way of an example, while the land use code provides a description of the activities taking place on that parcel, it may also give an indication of the volume of reticulated water required by that parcel. The converse also holds. That is, the amount of water available may determine the land use. Land use is thus a descriptive attribute of the parcel; the availability of water is a parcel or land related attribute.

The aim of parcel-based information systems is to utilize information of the type represented in Table 7.1 and integrate it to form a comprehensive resource of information suitable for a wide range of activities. The formation of such a resource does not necessarily imply the physical establishment of large centralized data bases. Rather, it means that systems must be able to physically and logically exchange and combine data sets in a manner determined by the particular application or user.

The integration process takes place in two ways. Spatially, all data relating to a parcel may be integrated if the definition of the parcel is the same in all data collections and it is identified by a common unique identifier. This may be either an existing index (e.g.

Table 7.1 Types of Land Information

Class	Sample Information Items
Natural Properties	slope, geology, vegetation
Real Property	ownership, equitable interests, easements
Fiscal	valuation, rates, land tax
Improvements	structures, land fill
Physical Planning	land use zoning, development, subdivision
Utility Services	electricity, water, gas
Public Services	roads, waste collection, health services

certificate of title reference), or a new identifier created for the purpose (e.g. a universal parcel identifier). Larger spatial units such as city blocks or census collector districts may be formed by combining parcels which, in turn, makes it possible to aggregate the individual parcel's descriptive data. Data collected on the basis of parcels may therefore be used for planning and policy decisions covering much larger spatial areas. Thus a second form of integration takes place between the operational data collected at the parcel level and the broad macro level data collected in most cases by different organizations and held at the planning and policy level. Potentially, the integration process transforms operational data to planning data in the course of which many benefits accrue, including reduced data collection costs and improved data reliability. 'In this way the job of collecting and updating is done by administrative departments for their own management purposes. Their reliability is ensured, since the data is used for management and since any error then can be corrected' (OECD 1978). The establishment of parcel-based land information systems therefore reduces the need to keep separate record collections for policy decisions by allowing the linking of data within and between systems directly through the parcel identifier or spatially through the geographic location of parcels.

The process of forming these data bases also yields a number of secondary benefits for the contributing agencies, including rationalization of data, a reduction in duplication, improved consistency and increased accessibility. These benefits are derived primarily from the 'computerization' of the data rather than any overall corporate information policy. These policies, however, form a catalyst, a framework to bring about an awareness of the commonality of data and the benefits flowing from the ability to freely interchange and combine data sets. The real justification, however, lies with the ability to use the same data at all levels for a multiplicity of local government functions (Jordan 1981).

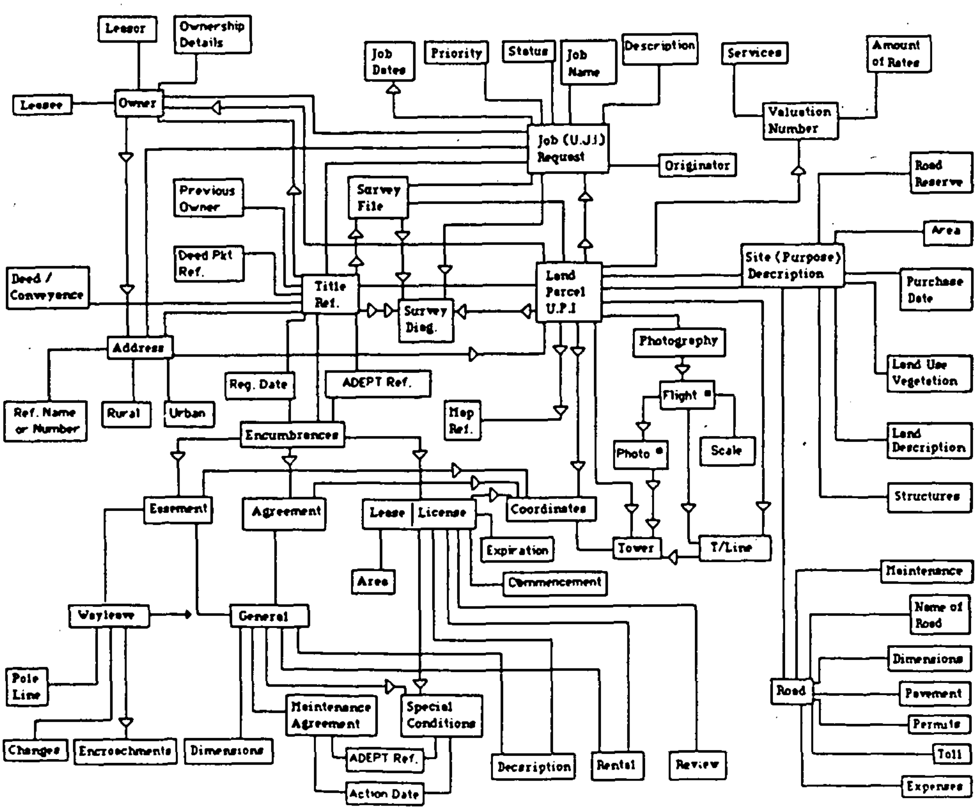


Fig. 7.1 Conceptual Schema for HEC of Tasmania Microcomputer Land Information System

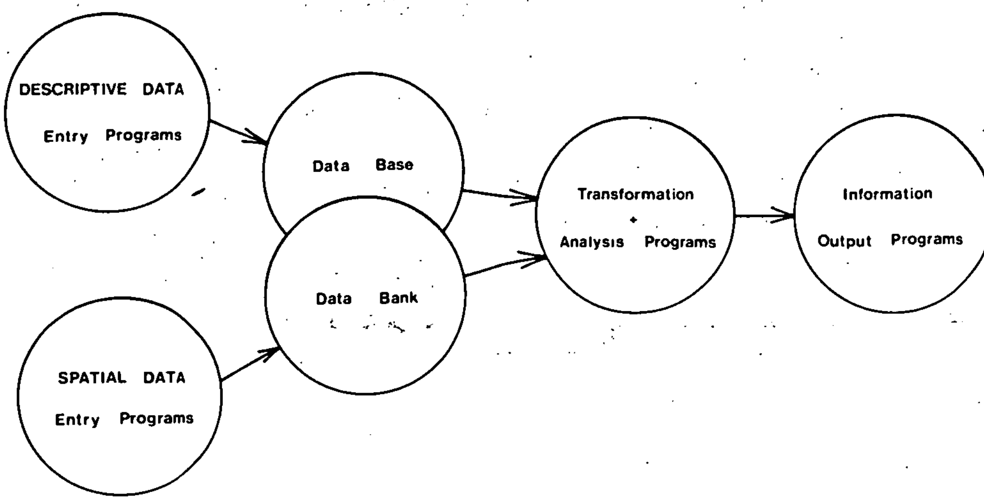


Fig. 7.2 Logical Structure of a Parcel Based Information System

COMPONENTS OF A PARCEL-BASED SYSTEM

Parcel-based information systems differ from, say, management information systems or decision support systems, by virtue of the fact that the data are spatially located and referenced by a common coordinate framework. The data in a system may therefore be spatially retrieved, analysed and displayed. Other data sets may have a geographic referencing capability via, say, named regions or street addresses, but these cannot produce quantitative data such as distance, area or relational information like nearest neighbours or enclosures.

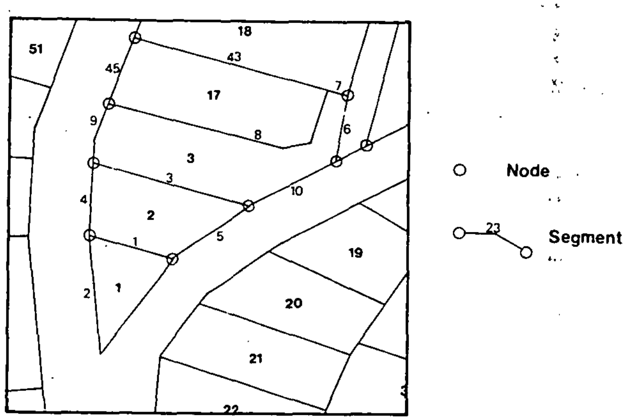
Attached to the parcels' locations are the data relating to that parcel such as land use zoning, valuation, ownership, etc. Conceptually, all information is referenced to the parcel's identification number or its location (that is, the only entity acknowledged within the data base is the parcel). There are, however, many other data flows and data relationships which require recognition (Figure 7.1) leading to the creation of additional entities, both spatial and non-spatial, during the implementation phase of a system. Furthermore, as spatial data have to be stored, manipulated and analysed in a manner not directly analagous to alphanumeric data, most operational systems physically, as well as logically, separate the attribute data from the spatial data. Parcel-based information systems may therefore be viewed as two separate data bases, one containing the locational data, the other a description of the characteristics of the parcel. This relationship is shown in Figure 7.2.

Spatial Data Organization

Traditionally, spatial data have been organized and stored in the form of maps which may be viewed as spatial analogues portraying and communicating information which varies across space. We take maps for granted and usually fail to regard them as a clever and compact way of storing geographic data. Just how clever maps are in storing information becomes apparent when attempts are made to transcribe this information into digital form.

Maps store two basic types of data: geometric (locational) data and topological or relational data. They explicitly store information on the size, shape, angularity and distance of objects, and implicitly store spatial relationships between them, such as adjacency, proximity, connectivity, enclosure, etc. These relationships between mapped objects are easily discernible from a map and in many instances are more important than the characteristics of the mapped objects themselves. For instance, while the location and size of a lake may be important, the fact that it is enclosed within one parcel affects the use of that lake and represents an important factor in determining the land use classification of the enclosing parcel. A spatial information system therefore has not only to store the geometric properties of objects, but also the implied relationship between objects.

The geometric attributes of objects may be conceptually subdivided and described as a hierarchy of ordered sets of points, lines and areas (Figure 7.3). Using these three elementary simplexes, the geometry of any object normally mapped may be digitally modelled. Further, data stored in this hierarchical structure enable each simplex to be viewed as a separate entity. The structure is therefore not confined to areal units, as the same spatial organization may be employed to reference information relating to points, such as sites of telegraph poles, to lines or networks, such as road centre lines or easements, as well as to areal or polygon-type data such as land parcels or administrative areas. The method is in wide use in a number of operating systems throughout the world including the digital cadastral data bases (DCDB) being implemented in a number of Australian states (Bennett 1982, Bryant 1983). It has the advantage of eliminating duplicate points and lines and restricting the storage requirements to lists of (say) pointers to establish the topology plus a single file of coordinates. Providing each entity type is given a unique identifier, then this may provide a link to the data structure holding the descriptive data of the entity. For technical reasons, other entities besides points, lines and polygons may be stored, for example, segments, node points and strings of points. Unlike the more general geographic information systems (GIS), parcel- based systems do not normally explicitly store any non-metric topological relationships although these may be derived through appropriate application programs.



PARCEL FILE

PARCEL Nº	SEGMENT Nº
1	1 2
2	3 4 1 5
3	6 7 8 9 3 10
	11 12 13 14 15 6 16
14	
15	41
16	43 7 15 41 44
17	8 43 45

SEGMENT FILE

SEGMENT Nº	POINT Nº
1	1 2
2	2 3 4 1
3	5 6
4	6 7 2
5	1 5
6	8 9
7	9 10
8	10 11 12 13
9	13 14 6
	5 8
41	
42	
43	56 10
44	55 57 56
45	56 58 13

POINT FILE

POINT Nº	AMG X	AMG Y
1	525754·3	5249511·6
2	525701·4	5249523·5
3	525702 1	5249504·9
4	525711·9	5249449·8
5	525801·2	5249546·8
6	525702·2	5249567·5
7	525700·7	5249547·1
	525850·9	5249574·0
	857·5	5249615·4

Fig. 7.3 Topologically Ordered Data Files

Descriptive Data Organization

Descriptive data attributed to the parcel may be held in computer files (usually index sequential) or in the more modern systems in a data base. In this respect the data do not differ substantially from those held in other large information systems. Using a unique name or number to identify the parcel and a spatial identifier, usually the parcel centroid, two-way links between the attribute and spatial data bases are established. These linkages are transparent to the user, who is unaware of the separate organization of the two data types when querying the system.

Leaving aside the description of the physical and natural characteristics of land parcels (e.g. topography, soil type, vegetation cover, etc.), the average parcel-based system useful to local government could contain between 100 and 300 items about the parcel. With this number of data objects, the relationships between them are very complex. Unless the parcel-based system is to be confined to one or two applications, then the use of flat files cannot be recommended unless very fast processors with virtual memory are employed, something beyond the capabilities of present microcomputer systems.

Conceptually, the only entity within the system is the parcel. This implies a one-to-many relationship between the parcel and its attributes. There are, however, many relationships between the attributes themselves. The organization of the data needs to recognize and formalize these relationships in the form of a schema (see Figure 7.1). At the conceptual level, the schema needs to define the data objects, the attribute or descriptive information about these objects, and relationship between occurrences of data objects. The organization of the data also needs to recognize the information needs and procedures of the people who contribute to, or use the data in the system. Each of these users may require to view and apply the data differently. For instance, planners, while using the same data, view information about dwelling improvements quite differently to valuers. One user views the data in terms of ascertaining land use, the other in terms of land value. The schema has to recognize these differences and allow each user to access the data independent from the requirements of another.

Entry of Spatial Data

The coordinates for the boundaries defining a land parcel may be obtained by a variety of techniques, the most common of which are direct numerical entry and the analogue to digital conversion (digitization) of mapped data. Direct digital entry of boundary data obtained from legal surveys connected to the Australian Map Grid (AMG) forms the most precise form. It relies on the existence of an overall survey control network at a high density of points to which surveys may be connected. This control system exists in a number of municipalities but is expensive to install and maintain (Zwart 1982a). It does, however, provide the highest possible precision, which is necessary for some information systems (such as those handling the location of utility networks for engineering purposes). Most information systems, however, do not require this precision and can therefore rely on less accurate and cheaper methods of digitizing large scale cadastral maps (with the final coordinate transformed to the AMG). The use of these methods does not exclude the coordinates being updated to a more precise value at a later date.

The entry of parcel boundaries into the system involves three items: the coordinates of points forming the boundaries; the relationships between these points (i.e. which point is connected to which point to form the boundary line and which boundary lines form the parcel); and lastly, a description or identifier for each of the points, lines and parcels involved. Several procedures have been devised to enter these data, the most efficient of which is the line-to-line method with automatic formation of point, line and parcel tables (Bennett 1982). Other procedures, while perhaps simpler, involve duplicating lines and points, and lead to aesthetically unacceptable results or may provide an inadequate representation of the parcel.

STATE PARCEL-BASED SYSTEMS

Local government has two main sources of information: internal data generated through its own operations and external data received from other jurisdictions and instrumentalities. Typically, external data include such parcel-based information as: changes of ownership and subdivision from the Registrar of Titles; property valuation for rating purposes from the State Valuer-General; and strategic regional planning data. In addition, most rely on the State for their base mapping and the Commonwealth for demographic data from the national census. These external data are combined with internally collected information to form the resource of data employed by local government authorities for operational activities and management decision making (Table 7.2). The creation of local government parcel information systems should therefore recognize and (where practical) encompass this external information (Johnston 1983). Examples of such operational parcel-based information systems in local government (albeit not microcomputer-based) are given in Table 7.3.

Table 7.2 Sample Parcel Specific Information in Local Government

Real Property Data	street name and number
	owner/occupier name
	title number
	lot/DP number
Fiscal Data	valuation
	assessment number
	rates notices
Planning Data	statutory planning restraints
	development applications/consent
	land use zoning
	planning certificates
Building Data	statutory restrictions
	building details
	building applications/consents/licences
Environmental Data	tree preservation orders
	foreshore height codes
	low lying land/flood levels
	unhealthy buildings
Engineering Data	road survey data
	road conditions
	maintenance programmes
	road widening
Miscellaneous	health licences
	dog licences
	immunization
	water analysis
	survey control

Table 7.3 Examples of Local Government Parcel-Based Systems

Authority	Reference
Blacktown City Council	Johnson and Brook, 1984
Shoalhaven City Council	Stasiukymas, 1984
Council of the City of Sydney	Nash 1980, 1982
Townsville City Council	Williams, 1980
Wollongong City Council	Broyd and Johnston, 1984

Every state government in Australia is currently endeavouring to establish a comprehensive, integrated parcel-based land information system. Even though the measure of support for these systems varies from state to state, as does the progress with the individual systems, it is reasonable to predict that state-wide parcel-based systems in one form or another will be operating in all states by the turn of the century. Most progress has been made in South Australia where the LOTS system now contains ownership, valuation and land tax information (Table 7.4). Developed in separate and self-contained stages, LOTS is now being conceived as one node in a total land information system for South Australia (Figure 7.4) including environment and socio-economic data gathered at the state level. Other states, while not as advanced as South Australia, are making significant progress. Of particular note are the activities of the Western Australian Land Information Support Centre (WALIS 1982), the Northern Territories Land Information System (Stephens 1983) and the LANDATA project in Victoria (Eddington 1984), which are attempting to co-ordinate and integrate the information contributions from a number of independent, established information systems. The prevailing philosophy (being the outcome of a number of failures and disappointments) is that state land information systems should consist of independent but functionally centralized systems where each authority retains administrative control over the data it collects and holds for its operational purposes. In this context, local government could be viewed as just another contributor and user to the system, that is, as one node in a totally integrated system. The organization of parcel-based information within a local government authority may also, in turn, be perceived as a number of interconnected and coordinated nodes.

Table 7.4 LOTS Data Base - Examples of Available Data

Title File (key = title ref)*	
Registered proprietor(s)	Estate (tenure)
Current address of proprietors	Sale details (date, price)
Parcel identification	Easement status
Encumbrances	Area
Conditions	Frontage
Administrative interests	Assessment No.
Valuation File (key = assessment no.)*	
Owner	Current values (site & capital)
Current address of owner	Proposed values (site & capital)
Address of Property	Year of last valuation
Approved land use (zoning)	Equalization factor (today's value)
Actual land use	Property improvements
Availability of services	Year of construction
Title reference	Tenancy apportionments
Land Tax File (key = owner no.)*	
Land taxpayer	Assessments in ownership
Current address of taxpayer	Property location of assessments
Legislative exemptions	Taxable value of assessments
Tax payable	

**Access Keys* = Title reference, parcel no., assessment no., street address, owner name, ownership no., lease reference (crown tenures).

Sales History File	
Assessment No.	Vendor
Sale date, price, type	Purchaser
Document No.	Type of roof
Style of house	Type of walls
Year of construction	No. of rooms
Land use code	Improvements
Property condition	Zoning
House area	Title reference

Access Keys = All fields, including ranges

Source: Sedunary 1984

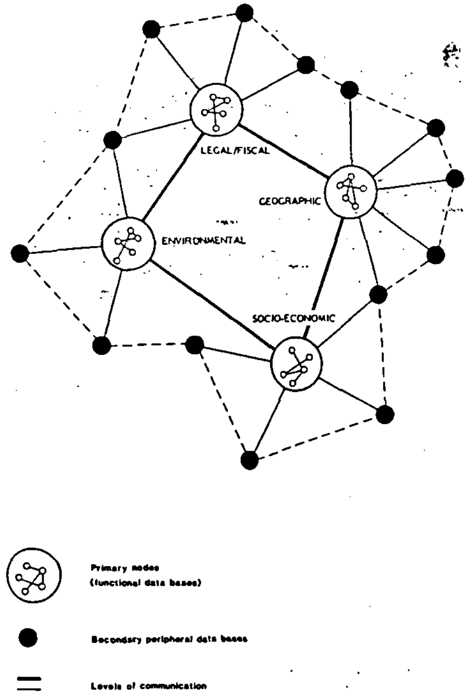


Fig. 7.4 Nodal Approach to a Land Data Base Configuration

There are, however, two main practical considerations mitigating against the view that local governments should be just another node in a wider system. Firstly, a local government may not be able to defer re-organizing its land information records until an external agency is in a position to provide the information it needs. This situation has, in the past, confronted a number of local governments and utility authorities (Williams 1980, Kelly 1980) who established independent systems to serve their immediate needs, but which inevitably resulted in duplicated data and higher than necessary capture costs. The latter applies particularly to the collection of spatial data. Authorities should, wherever possible, avoid this activity if a state DCDB is forthcoming in the foreseeable future. Or, as many of the benefits of parcel based information systems are obtainable from the descriptive date base only, establish this and leave the spatial portion to a second stage (Johnson and Brooks 1984). The other major difficulty relates to the exchange of data between independently created systems. Problems arise at two levels:

1) the first concern is the use of standard codes, classification and terminology to describe the information entering a system. Few, if any, standards exist, for example in relation to land use coding, description of improvements, estates in land, or even street addressed data.
2) the second relates to the physical format of the data. At the technical level, each computer manufacturer has different systems architecture and hardware/software incompatible with those of other suppliers. It therefore becomes very difficult for data stored in one computer to be intelligently exchanged with data in other systems.

Neither problem is easily solved or overcome. Attempting to impose centrally determined codes and formats is an unrealistic option and has little regard for the real differences between land records and user requirements. Efforts are therefore concentrated on establishing standards for the interchange of digital land information (Lister and Southwell 1984). This standard provides for the interchange of such parcel-based information as parcel identifiers, name street address and valuation assessment number, as well as spatial information, including the coordinates of parcel boundaries, local government areas, census districts and electorates. Devising standards is, however, a very complex and protracted activity containing within it the dilemma that when the interagency needs for exchange are realized, individual agencies will normally be already committed to their own system design. Despite this it would be foolish for local governments to attempt to establish their own independent parcel-based information systems if much of the information could be obtained from without by agreeing to, and conforming with, data exchange standards.

ROLE OF MICROCOMPUTERS

General Remarks

The suitability or otherwise of microcomputers to implement a parcel-based information system involves the selection and evaluation of a number of inter-related factors, chief amongst which are the user's needs, organizational requirements, data volumes, data complexity and data response times.

A number of characteristics have made the use of microcomputers popular. Amongst these are the fact that they are usually managed by individuals or small sub-units within an organization. Microcomputers have therefore shifted the emphasis towards end user computing with its associated freedom from restrictions, standards and control of central data processing departments. As Brown and Sefton (1984) state, 'the advantages of a micro are its low costs, its fast, consistent response, its availability and portability, its freedom from establishment, and some of its software'. This 'deregulation' of computing reduces the need for user groups to adhere to externally agreed definitions, standards and procedures. This feature of microcomputers runs counter to the notion of a corporate local-government-wide information resource inherent in the parcel-based concept. Although the microcomputer may improve costs and efficiency for a particular task, few benefits flow to other potential users of the data. The introduction of microcomputers into a local government needs therefore to be part of an authority-wide information technology plan (see Chapter 4), containing a management structure to compel individual users to comply with agreed standards and operational procedures.

Technically, all 16-bit microcomputer systems are capable of implementing the storage, retrieval and analysis associated with parcel-based information systems. Their use, however, should be restricted to systems not likely to exceed about 30 000 parcels, that is, approximately 12 megabytes of data. The reason for this is that while large amounts of disk storage are available, the use of comparatively slow CPUs, secondary memory and slow access times tend to make response times unacceptable.

Functional Considerations

Two broad uses need to be distinguished: systems designed to serve a single user and, secondly, systems designed for multiple tasks. Single purpose systems not requiring spatial analysis capabilities can be successfully created using off-the-shelf file management packages. Providing the data relationships are not too complex, data volumes acceptable (around 10 000 items) and queries on the system straightforward (that is, involving few computations or logical operation), systems based on the packages can provide acceptable response times and products commensurate with the costs of the system's establishment (Zwart 1982b). Should the system's specifications, however, include spatial data handling or complex conditional retrievals, packaged file management systems are inappropriate. It should also be noted that while a number of file management systems offer an external file format for the transfer and interchange of data, these are generally non-standard formats.

Any applications requiring the storage-retrieval-analysis of spatial data or alphanumeric data with complex entity and attribute relationships need to be based on high level language software, addressing fully implemented data base management systems (DBMS). There are presently no general packages of this type available for parcel-based systems, save a set of generic programming tools and support software for utilization by systems designers or users skilled in computing science. The reason for this is that the implementation process goes well beyond the computing skills normally connected with microcomputers (Figure 7.2). Designing a data base involves the selection and organization of entities, attributes and relationships for both spatial and non-spatial data items into a schema which serves a number of purposes (Love 1985). The use of standard systems and programming tools makes the implementation of multi-user parcel-based systems on microcomputers not very different from systems on larger processors. The one difference which is likely to remain is the use of small project teams of one or two people closely working with the users to implement the system.

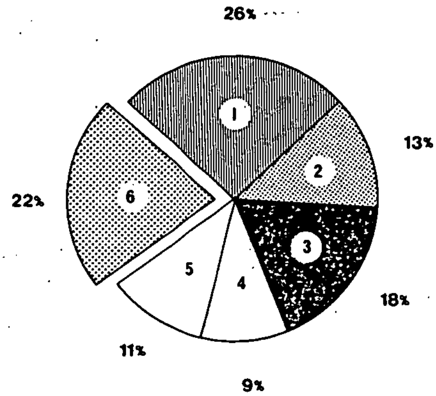
Physical Implementations

Few parcel-based systems have been installed on microcomputers. This is not due to an inability of microcomputers to handle these systems. Rather, it relates to the following factors: suitable microcomputers have only become available comparatively recently; commercially available software is lacking; a dearth of appropriately skilled and experienced people; and insufficient awareness of the capabilities of microcomputers and parcel-based information systems in general. The majority of implementations have been in North America of which the City of Cleveland system (Hayes and Fauquier 1983), the City of Petaluma (Tupa 1983) and the Pykes Pede Area Council of Governments (Johnson 1984) are notable examples. Each of these are integrated municipal-based systems catering for the needs of a wide range of departments through a local area network of microcomputers. Their use extends from environmental impact and analysis requiring data on vegetation, soils, slope, geology, watershed, archeological and historical data to regional transport analysis and physical planning requiring the creation of files for vacant commercial and industrial land, the status of development activity in the city and the fiscal impacts associated with development (Nore and Bamberger 1983). These systems confirm the often cited but rarely substantiated benefits of networks of microcomputers – namely the ability of the system to grow continuously as its user population grows, and their superior cost/performance ratio compared to time share minicomputer installations (Zwart 1984).

Reports on installed parcel-based systems on stand alone microcomputers are very few. In Australia the system developed for the Hydro Electric Commission in Tasmania appears to be the first and only system of this type. The product of a University research project, it is based on a full CODASYL network data base. Between this data base and the user there resides a sophisticated and flexible data interface program (Love 1985). Provisions have been made in the schema to incorporate a link to a spatial data base when this becomes necessary.

Installation Costs

Often the reasons for selecting a microcomputer over other computer systems are their relatively low hardware costs and the availability of low cost application software packages. These benefits are real while the task to be implemented remains simple, and the complexity of the problem such that it may be successfully completed by unskilled end users. The implementation process for anything but the simplest parcel-based system, however, is virtually the same irrespective of the hardware on which the system is being installed. To demonstrate this point, the cost of installing the stand alone microcomputer system for the Tasmanian Hydro Electric Authority is shown in Figure 7.5. As indicated, the hardware component constitutes about 20 per cent of total expenditure. A two-fold movement in the price of the microcomputer system would thus affect the total systems cost by only about 10 per cent. Single user microcomputer systems are therefore relatively insensitive to equipment costs. Consequently, unlike many other applications, individual microcomputers for parcel-based systems offer few cost benefits over medium sized minicomputer systems. Network microcomputer systems, on the other hand, hold distinct cost advantages over multi-users time shared minicomputer systems (reductions in the order of 45 per cent on a seven terminal system are achievable, (Zwart 1984).



	ACTIVITY	$
1	Requirements Analysis and Formulation	12,000
2	Schema Design and Implementation	4,000
3	User Interface Software	8,000
4	Queries and Application Software	6,000
5	Database Management Software	5,000
6	Hardware	10,000
	Total	45,000

Fig. 7.5 Installation Costs of Stand-Alone Microcomputer LIS

CONCLUSIONS

While few parcel-based systems have been implemented on microcomputers, this situation is expected to change rapidly through improvement in microcomputer technology and through a demand by citizens for better management and land use decision making by local government. Fulfilling these requirements will involve such organizations creating an authority-wide corporate resource of parcel-based information. Microcomputers are capable of performing this function and offer a sophisticated alternative for medium and small size authorities.

At the same time, the shift towards end user computing implied by the widespread use of microcomputers could, without appropriate managerial arrangements and procedures, be a force diminishing the awareness of the need for agency wide information systems to support the increasingly complex and interrelated decisions facing all levels of government. The challenge for microcomputer-based parcel information systems is therefore not so much one of how to harness their technical prowess, but ensuring that the very qualities which have made microcomputers so popular (namely the demystification of computing and information management) do not inhibit the establishment of an information system capable of serving the total community - local government officials and citizens alike.

REFERENCES

Bennett, W.V. (1982), 'The Western Australian Digital Cadastral Mapping Sub-system', *Proceedings of URPIS 10*, pp.456-490.
Brown, G.D. and Sefton, D.M. (1984), 'The Micro *vs* The Application Logjam', *Datamation*, 30, pp.96-104.
Broyd, D. and Johnston, C. (1984), 'Land Information System Development by Wollongong City Council', *Proceedings of URPIS 12*, pp.1-2.
Bryant, F.L. (1983), 'A Digital Cadastral Data Base for South Australia', *Proceedings of URPIS 11*, pp.9-13.
Collier, A.J. (1983) 'Property Information from a Codasyl Database', *Proceedings of URPIS 11*, pp.23-27.
Eddington, R.A. (1984), 'The LANDATA Project - a Statewide Computer Based Land Information System for Victoria', *FIG Commission Symposium on the Decision Maker and*

Land Information Systems, Edmonton.
Hayes, E.E. and Fauquier, J.E. (1983), 'Organizing the Cleveland Land Data System Around Microcomputers', *Papers from the Annual Conference of URISA*, pp.194-208.
Hodgkinson, R. (1984), 'A L.I.S. Calls for Some Hard Nosed Decision Making in Individual Sub-Systems', *FIG Commission Symposium on the Decision Maker and Land Information Systems*, Edmonton.
Johnson, B.H. (1984), 'Establishment of a Microcomputer Resource at a Medium-sized Metropolitan Planning Organization', *Papers of the Annual Conference of URISA*, pp.72-77.
Johnson, D. and Brooks, D. (1984), 'BLIS: Blacktown Land Information System', *Proceedings of URPIS 12*, pp.25-28.
Johnston, C. (1983), 'Integration of Land Information Systems: Wollongong City Council - Sydney Water Board,' *Proceedings of URPIS 11*, pp.15-28.
Jordan, P. (1981), 'The Organisational Impact of Data Base Computing Techniques on Local Government,' *Proceedings of URPIS 9*, pp.1-10.
Kelly, B.P. (1980), 'Cadastral Mapping and Electricity Utility', *Proceedings of URPIS 8*, pp.1-7.
Lister, R. and Southwell, P. (1984), 'Standard for the Interchange of Digital Land Information Data', *Proceedings of URPIS 12*, pp.7-18.
Love, W.R. (1985), 'A Microcomputer Based System for Managing Land Information', *Australian Surveyor*, 32 (in press).
Nash, K.R. (1982), 'The Data Extraction and Presentation System: A New Tool for Planners and Decision Makers', *Proceedings of URPIS 10*, pp.312-338.
Nash, K.R. (1980), 'The 1980 City of Sydney Strategic Plan - the Formulation of a Corporate Policy Document at the Local Government Level', *Proceedings of URPIS 8*, pp.30.1-30.10.
Nore, D. and Bamberger, W.J. (1983), 'New Frontiers: Micro-Based Fiscal Analysis and Management Information Systems', *Papers from the Annual Conference of URISA*, pp.306-312.
OECD (1978), *Local Government and Information Technology*, Information Studies 12, Organization for Economic Cooperation and Development, Paris.
Sedunary, M.E. (1984), 'LOTS, and the Nodal Approach to a Total Land Information System', *FIG Commission Symposium on the Decision Maker and Land Information Systems*, Edmonton.
Stasiukynas, A. (1984), 'Shoalhaven City Council's Property Information Management System', *Proceedings of URPIS 12*, pp.1-18.
Stephens, V. (1983), 'L.I.S. - The Northern Territory Experience', *Proceedings of URPIS 11* pp.6-11.
Tupa, M. (1983), 'Microcomputer Applications in City Planning', *Papers from the Annual Conference of URISA*, pp.294-305.
'VALTAX System for Tasmania' (1984), *AURISA News*, 84 (2), p.12.
WALIS (1982), *Western Australian Land Information System Reference Guide*, Land Information System Support Centre, Perth.
Wilkinson, M. (1980), 'The Integration of the NSW Valuer General's Computer System into the Sydney Water Board's Computer System', *Proceedings of URPIS 8*, pp.1-10.
Williams, R.H. (1980), 'Development of a Central Land Data Base and Map Base System for Townsville City Council', *Proceedings of URPIS 8*, pp.1-9.
Zwart, P.R. (1982a), 'Some Suggestions for Improving the Cost Structure of Integrated Survey Systems', *Australian Journal of Geodesy, Photogrammetry and Surveying*, 37, pp.79-99.
Zwart, P.R. (1982b) 'A Microcomputer Based Land Information System', *Proceedings of URPIS 10*, pp.48-60.
Zwart, P.R. (1984), 'Decision Making, Land Information Systems and Microcomputers - Some Experiences and Suggestions,' *FIG Commission Symposium on the Decision Maker and Land Information Systems*, Edmonton.

FIG XVIII INTERNATIONAL CONGRESS
TORONTO, CANADA, 1986

THE PRODUCTION OF INFORMATION FOR POLICY DECISIONS FROM LAND INFORMATION SYSTEMS

LA PRODUCTION DE RENSEIGNEMENTS POUR DES DÉCISIONS POLITIQUES DES SYSTÈMES D'INFORMATION FONCIÈRE

DIE PRODUKTION VON INFORMATION FÜR VERFAHRENS RICHTLINIEN BASIERT ANF LAND INFORMATIONS SYSTEMEN

P.R. ZWART

ABSTRACT

Land information systems in Australia have developed to the stage where the post-implementation issues of system management and system evaluation need to be addressed. This paper outlines the factors influencing the need and use of information derived from LIS at the strategic policy levels.

RÉSUMÉ

En Australie, les systèmes d'information foncière sont développés au point que la mise en oeuvre des issues sur l'aménagement et l'évaluation des systèmes ont besoin d'être pris à tâche. Ce dossier donne un profil sur les conditions qui influences le besoin et l'utilization de l'information dérivées des systèmes d'information foncière au niveau de plans stratégiques.

ABSTRAKT

Land Informations Systeme sind nunmehr in Australien soweit entwickelt, daß - nach deren Einsatz-Systembehandlungs - und Bewertungsprobleme angesprochen werden müssen. Der vorliegendre Artikel behandelt einige Faktoren, welche die Notwendigkeit und den Nutzen von Information ans Land Information Systemen für Richtlinien von strategischen Nivean beeinflussen.

NVITED PAPER, COMMISSION 3 XVIII FIG CONFERENCE, TORONTO, JUNE 1986

Introduction

Many of the conceptual models of land information systems discussed during the early 1970s viewed these systems as a means to create centralised resources of information about land, to which all could contribute and from which all would benefit. Engendering a corporate notion of information has remained a central theme of land information systems evolution since those early days. The practice of implementation by incremental steps, however, has tended to obscure that just such a resource would be created once discrete information systems became linked.

In at least five of the Australian States it is clear that the major institutional and technical obstacles to the creation of comprehensive state-wide information systems for routine land administration have been overcome. Although in most jurisdictions, only components of the systems are in place, it appears reasonable to assume that operational systems (at the administrative level) embodying multiple functions and multiple users will be common place within a decade. Given this stage of development, it seems appropriate to start to examine some of the post-implementation issues associated with the systems' management, including a definition of the bounds or limits to the use of the information resource.

This paper will discuss one aspect of this problem, namely an evaluation of the factors influencing the use and need for information derived from land information systems at the strategic policy level.

The Transformation of Information

Unlike problems at the administrative level, those at the policy level tend to be ill-defined and open-ended. There is little agreement on what constitutes the problem, the type and quantity of information required, or in many instances, the solution sought. Typically, they are complex, multi-faceted, non-routine problems generally not amenable to factual or empirical questions regarding the sorting out of different value preferences between people as individuals, in groups, and in organisations [Parker, 1975]. Decisions at the policy level thus involve a significant human aspect, a significant decision analysis, content and judgement.

By way of contrast, problem solving at the administrative level has been made routine, i.e. the rules and procedures for a myriad of daily decisions have been institutionalised [Inbar, 1979]. There is thus a consensus regarding the definition of the problem, the resource required to solve it, and the method of solution. It is assumed that a solution exists, that it will be optimum and that the solution and the means are objective and quantifiable [Linston, 1984]. Little or no judgement is required as explicit rules and procedures govern the outcome.

The land information systems being established in Australia and elsewhere are, in the main, attempts to improve the management of information for the administration of land. As such, the data the systems collect, their definition, structure and organisation is indicative of the administrative functions it is intended to fulfil. The characteristics of the information required at the policy level however, are quite different (Table 1).

To produce information to assist in policy formulation and policy analysis from land information systems will therefore require a transformation of information from an administrative form to a policy form. While this transformation will involve contextual, structural, relational and perspective changes to the information, the precise nature of the transformation cannot be determined until the domain into which the information is to be changed is defined.

Some Attributes of Policy Level Information

To define, in absolute terms, the contribution land information systems can potentially make to the information requirements of the policy domain is neither feasible, nor meaningful. It is clear from Table 1 that they are both very wide, heterogeneous and diverse. Moreover, as Stabell [1984] indicates, these requirements will vary a great deal across decision makers and across decision situations. Instead, a preliminary attempt will be made to describe the characteristics of both the information (in terms of its availability) and how or why it may be used. To do this, three broad variables linking information from land information systems to information requirements and information utilisation in the policy arena are identified below. While their description is neither complete nor exhaustive, they do outline the main issues defining the role of information in the policy decision making process. They also focus on, and extend the differences in information requirements identified in Table 1.

Table 1 - INFORMATION REQUIREMENTS BY DECISION LEVEL

INFORMATION CHARACTERISTIC	DECISION CONTINUUM		
	Operational	Planning	Policy
Source	Largely internal	....	Largely external
Scope	Well defined, narrow	....	Very wide
Level of detail	Detailed	....	Aggregate
Time horizon	Present	....	Future
Currency	Highly current	....	Quite old
Required accuracy	High	....	Low
Type of information	Quantitative	....	Qualitiative
Frequence of use	Very frequent	....	Infrequent

Adapted from [Shoeck and Schkade 1981]

Communication of Information

The dissemination of information process between the land information resource and the user should be such that it promotes the reception, transformation, consumption and hence utilisation of the information in the policy formulation, analysis and decision making stages. The first two of these processes, reception and transformation, are critical and the most difficult to achieve. They are critical in that the problem to be solved and the relevant knowledge base must be in the same information system [Parker, 1975] and viewed from the same perspective. Often this is not the case because of the disparate beliefs and values held by different people on how to solve a problem [Portner and Niemann, 1984] or because the perspective (technical, organisational or personal) from which it is viewed presents a different picture of the problem under consideration [Linston, 1984]. In many cases, there will also be differences in interpretation, attribution and inference between the information source and its user leading to 'cognitive mismatches', either perceived or built into the communication channel [Sproull, 1984]. The information system and user thus seem to exist in two different worlds [Chen and Hernon, 1984].

These are real problems at the policy level, not only because of the diversity of information that has to be collected, analysed and evaluated, but also because usually the resultant policies/decisions have to be communicated to an equally diverse audience. The routine information derived from land information systems will therefore have to acquire a change of value as well as the structural changes summarised in Table 1. Altering the perceived value of the information to enhance reception will involve a contextual and semantic modification, rephrasing and changes in terminology, plus emphasising (rendering salient) different data sets and relationships for a number of perspectives, logical structures and purposes.

Information Seeking

Given that this metamorphosis of information can be effected, i.e. the availability and form of information is no longer a constraint, it does not necessarily follow that this information will be sought out or used in the policy/decision process. As Chen [1982] notes, an information source does not become an information provider by its own action, until, and unless it is so defined through the actions and behaviour of the individual/organisation seeking information.

There is evidence to suggest that people may not be particularly interested in obtaining new information or there may not be any stimulus to trigger information seeking behaviour [Mick, 1981]. Admitting new and different information products denotes a change - a departure from the established procedure. As such, the new information product represents a change process, which is unlikely to be accepted unless it satisfies, and maybe assimilated with, unfulfilled personal, organisational or economic needs [Glazer, 1983].

In the past, the ability to satisfy these needs by seeking information, has been limited in two seemingly opposing ways - the non-availability of information whose use, when available, is limited by the information processing capacity of the decision maker (Lindblom's incrementalism). As a result, decision makers have tended to take decisions which do not differ much from the status quo. While the use of information technology may partially extend both the availability and analysis capacity, it will not in itself provide a stimuli unless the social reward structure for information related behaviour is changed. Presently there is little reward to change from seeking information from interpersonal sources - the dominant behaviour [Chen, 1982] or to perceive formal information systems as an unwelcome, irrelevant intrusion [Nijkamp, 1984].

To have the products of LIS accepted at the policy level will thus necessitate encouraging or deliberately manipulating a different perception of information, its role and value. In part, the solution is technical in that alternative forms of information representation need to be devised [Zwart, 1984]. In part, educational by increasing the information handling skills of the population [Mick, 1981] and, in part, social - through an increased need to effectively assess the interdependency and consequences of "optimal" decisions [Madnick, 1977].

The Quality of Use

While the information provider normally does not, and should not, have control over how the released information is used, the manner in which the information is utilised (the quality of the decision made through its use) does affect the form and type of information to be delivered.

The literature shows a mixed pattern of information usage. Information, in particular technical information, is likely to be severely discounted as evidence [Linston, 1984] and at best play a minor role in the decision making process [Nijkamp, 1984]. People, in general, will avoid the use of information that they do not understand or control [Danziger, 1982]. When information is used, it may be very indirectly, in a conceptual rather than instructural mode [Weiss, 1980]. Computers, and what they represent, may be adopted by users without having any real impact on organisational or decision outcomes. They may have only a symbolic meaning and have little or no rational use [Weisband, 1985]. The meaning of rationality and symbolism may become somewhat blurred when information is used to justify a decision already made [Kraemer, 1981].

Put together, this diversity of use reflects the earlier comments that decision makers on the whole are relatively unsophisticated users of information and unsure of its value or role. Behaviourally and cognitively, there are unskilled information handlers. This position will ony be changed through education and the recognition that information is an economic and social resource [Sweeney, 1982]. In the meanwhile, present usage patterns have to be acknowledged and incoporated as design constraints in the production of information for policy decisions.

Concluding Remarks

Superficially information held in computer based land administration systems appear to offer little of advantage to the policy/decision making process. While this is at least partially true for the information per se, this cannot be said about the institutional and technical framework employed for its collection and organisation.

Land information systems, by their nature, offer an integration mechanism, a common classification (taxonomy) of information and an institutional arrangement to collect, maintain and verify land information. Dynamic, systematic, organisational and technical procedures for the assembly, storage and dissemination of policy level information, except as specific periodic surveys have been lacking and hampered the acceptance and use of information in the decision making [Davis 1974, Hudson 1985]. Land information systems therefore offer a mechanism to upgrade the quality, availability and timeliness of information to the policy level.

If at the same time we can develop the technical means to transform the data itself, to transfer information between value sets and a social infrastructure to reward information seeking and usage behaviour, then the resource of administrative land information we are creating has the potential to be of use to a much wider community.

References

Chen, C.C. and Hernon, P. (1982), Information Seeking: Assessing and Anticipating User Needs. New York, Neal-Schuman.

Danziger, J.N. (1982), Computers and Politics, New York, Columbia University Press.

Davis, M. (Ed) 1974, Environmental Information: Some Problems and Solutions, Centre for Environmental Studies, University of Melbourne.

Glaser, E.M. (1983), Putting Knowledge to Use, San Francisco, Jossey-Bass.

Hudson, K.I. (1984), Developments in Property Systems. In England, J.R. (Ed), Information Systems for Policy Planning in Local Government. Harlow. Essex. Longman.

Inbar, M. (1979), Routine Decision-Making: The Future of Bureaucracy. Beverley Hills. Sage Publications.

Kraemer, K.L. (1981), The Management of Information Systems, New York. Columbia University Press.

Linstone, M.A. (1984), Multiple Perspectives for Decision Making. New York. North-Holland.

Madwick, S.E. (1977), Trends in Computers and Computing: The Information Utility. Science, 195, pp 1191-1199.

Mick, C.K. (1981), Potential STI Innovation: A Behavioral Perspective. In Mason, R.M., and Creps, J.E. (Eds), Information Services: Economics, Management and Technology, Boulder, Westview Press.

Nijkamp, P., and Rietveld, P. (Eds) (1984), Information Systems for Integrated Regional Planning, Amsterdam, North-Holland.

Parker, E.B. (1975), Who Should Control Society's Information Resources. In Kochen, M., (Ed), Information for Action, New York, Academic Press.

Portner, J. and Niemann, B.J. (1984), An Overview of the Social Aspects of Land Records Modernization. In Niemann, B.J. (Ed) Seminar on the Multipurpose Cadastre: Modernizing Land Information Systems in North America, IES Report 123, Institute for Environmental Studies, University of Wisconsin-Madison.

Schoeck, R. and Schkade L.L. (1981), Human Services Workers as the Primary Information Systems User, Papers from the Annual Conference of URISA.

Sproull, L. (1984), Thinking About Implementation, Committee on Social Science Research in Computing, Working Paper, Carnegie-Mellon University.

Stabell, C.B. (1983), A Decision-Oriented Approach to Building DSS. In Bennett, J.D. (Ed.) Building Decision Support Systems. Reading, Mass., Addison-Wesley.

Sweeney, G.P. (1982), The Industrial Firm in the Information Economy. In Sweeney, G.P. (Ed), Information and the Transformation of Society. Amsterdam, North-Holland.

Weisband, S.P. (1985), Rational and Symbolic Aspects of Introducing Computing: The Case of an Executive Information System, Committee on Social Science Research in Computing, Working Paper, Carnegie-Mellon University.

Weiss, C.H. (1980), Knowledge Gap and Decision Accretion. Knowledge 1 (3), pp 381-404.

Zwart, P.R. (1985), Decision Making, Land Information Systems and Microcomputers - Some Experiences and Suggestions, Papers from the FIG International Symposium, Edmonton, Alberta.

User Requirements in Land Information System Design—Some Research Issues

by Peter Zwart

Abstract. Land information systems have developed to the stage where comprehensive resources of land information are being created. Our methods to determine the user needs, however, remain inadequate. Also of concern is the dearth of knowledge of how, when, or if this information resource will be used. This paper identifies a number of research issues related to these concerns.

Introduction

Research into land information systems (LIS), in particular, and land information management (LIM), in general, has concentrated on the technical issues associated with the building and maintenance of computer-based systems to improve land recordkeeping and land administration. To this end, considerable resources have been devoted to gaining an understanding of how to identify the shortcomings of existing recordation systems, how to restructure and transform them to digital form, and how to devise adequate storage, retrieval, and dissemination mechanisms. Judging by the number of operational systems around the world, a reasonable insight appears to have been acquired into the implementation and management of these new information delivery systems.

It is now recognized that to succeed, implementation strategies require the technology to adapt to and blend with the existing organizational and institutional structures. The most successful means of achieving this marriage has been physically distributed (network) systems with individual "ownership" and responsibility for data, linked together by an agreed framework of standards and control (Palmer and McLaughlin, 1984; Zwart, 1984). Although this arrangement appears to create a system substantially different from the monolithic centralized plan proposed in the 1960's, conceptually and operationally this form of a land information system produces a comprehensive resource of land information capable of a wide range of products for a variety of users throughout the community.

To what purpose this resource may be employed, however, is a poorly researched topic. The means of determining if, how, or when this resource will be used are also less than perfect. The remainder of this paper will discuss nine research issues related to these topics.

A Classification of Problems

Land information systems create corporate or communitywide information resources to assist in reducing uncertainty in problemsolving and decisionmaking about land. Narrowly, the product is information; the purpose is reducing uncertainty. To facilitate discussion, a distinction will be made between systems designed to provide information for solving structured problems and those aiming to assist in the solution of unstructured problems.

Structured problems are those about which there is a consensus regarding the definition of the problem, the resources required to solve it, and the method of solution. It is implicitly assumed that a solution exists, that it will be optimum, and that the solution and the means are objective and quantifiable (Linstone, 1984). The routine problems at the administrative/operational and management levels are almost exclusively of the structured type. Structured problems are less frequent in the planning process and rare at strategic policy levels.

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Unstructured problems, on the other hand, tend to be ill-defined and open-ended with little agreement on what constitutes the problem, the type and quantity of information required, or the solution sought. They are complex, multifaceted problems generally not amenable to factual or empirical questions and require the sorting out of different value preferences among people as individuals, in groups, and in organizations (Parker, 1975). Unstructured problems thus involve significant judgment, a significant policy, and/or decision analysis content and, hence, are mainly found at the planning and policy levels. The boundary between the two types of problems is obviously blurred toward the middle where they transit from the simple to the complex, from the tame to the wicked (Rittel and Webber, 1973). Clearly, the information needs and the means to satisfy these needs will be quite different for each problem type.

User Needs and Systems Design for Structured Problems

The stages in the development of an information system for structured problems usually comprise a feasibility study, the definition of requirements, systems specifications, systems design, program design and development, systems testing, and finally the implementation and maintenance. Modifications to this basic procedure for geographic information systems development have been proposed by Calkins (1977). In each case, the basic philosophy is the same: A systems analyst defines the user requirement through surveys, interviews, data dictionaries, and similar sources and builds a system to serve a number of functions which are verified (or not) to equal the user requirements during the installation, "tuning," and maintenance phase (Fig. 1(a)).

Despite careful and extensive documentation at each stage and the emergence of a number of design tools to refine the process, it is becoming apparent that present design methodologies have a number of shortcomings. Chief among these are poor definition of user requirements due to incomplete, inconsistent, incorrect, or ambiguous specifications. The reasons for this include the following:

1. Some users find it difficult to describe the information they need or to comprehend how these needs may be satisfied by an information system.
2. The user and the systems analyst communicate poorly due to different backgrounds and vocabularies. This leads to misunderstanding and documentation that does not adequately depict how the system will function (Segall, 1984).
3. The user is not sufficiently involved in the design of the system due to lack of feedback.
4. User requirements change between the inception of the system and its delivery due to protracted implementation time.

In many instances, the cause of these difficulties is that the user has had little or no exposure to computers, let alone to the capabilities of information systems. He cannot visualize the eventual system, particularly in the form of written specifications (Fig. 1(b)) (McCracken, 1980). This point was driven home during a demonstration and hands-on experience session on a microcomputer-based LIS (Zwart, 1982) in the office of a local government administrator. Those involved were proud of the user interface—the *piece de resistance* of the system—but lost the administrator because the function of the return key had not been described. This, and subsequent experiences, has led to the belief that the land information management community tends to overestimate the computer awareness of the individuals and organizations with which it deals. This view is supported by the findings of Danziger (1982).

Present systems development procedures do not contain a user educational and familiarization component explicitly designed to make users aware of their options as to how the system will be implemented, the type and extent of the products it could deliver, or how the system will function.

Research and development need to be undertaken to develop an improved systems analysis and development methodology for land information systems which includes a component to enable users to learn and become familiar with the operation and functions of an LIS *prior* to the finalization of the systems specifications.

A promising line of investigation in this

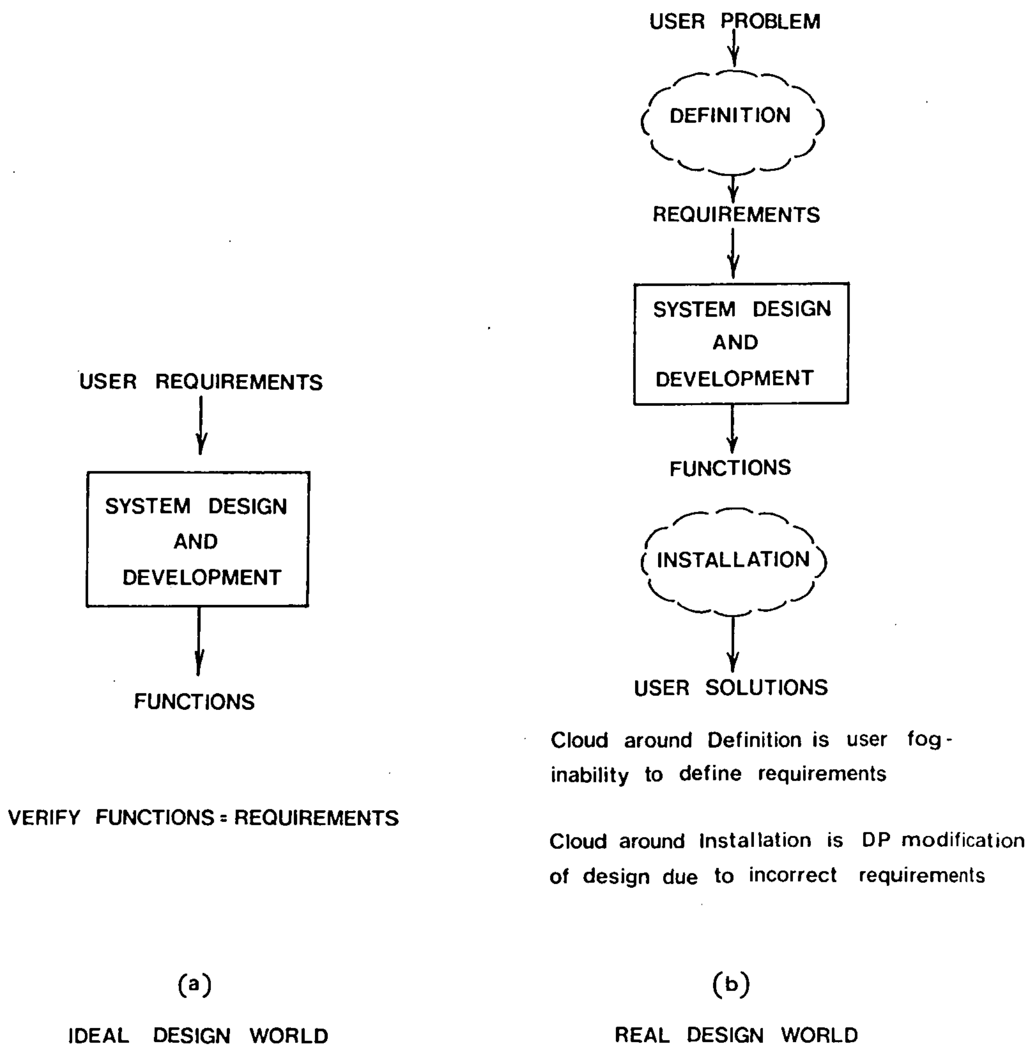

Figure 1. (Adapted from Segall, 1984.)

regard is the use of prototype systems. Being the first of its type, a prototype system is a live, working system with which a user may test out assumptions as to requirements, system design, and function. They set up an iterative process beginning.

> ... with a simple prototype that performs only a few of the basic functions in question. It is not required that these functions be performed elegantly or efficiently. But it is expected that, through use of the prototype, system designers or end users will discover new requirements and refinements which will then be incorporated in the next version. [Canning, 1984]

The use of prototypes enables a user to clarify his requirements dynamically. It necessitates and promotes a high user involvement (bringing about a stronger commitment), presents a working model early in the project, and gradually transfers its operation to the user. Further details of prototyping as a design methodology may be found in Segall (1984).

To be successful, prototypes have to be developed quickly, within days or weeks, rather than months. In general, this has been made possible by the advent of 4GL programing, database management systems, and packaged software. Sufficient tools of this type are now available to make the prototyping of land information systems, including the graphical component, feasible.

A prototype system of this type is to be used by the School of Surveying, University of Tasmania, Australia, to assist in the systems analysis for an information system containing the underground workings of a very large tin mine. This approach is being used to reduce the effects of the following:

1. A relatively unsophisticated user population;
2. A prolonged implementation time with consequential loss of user interest and project momentum;
3. Unorthodox data and data capturing procedures; and
4. Research and development time necessary to develop appropriate database and display systems.

In addition to the above problems, there has also been an unfortunate tendency in systems design to emphasize the technologically glamorous aspects (the use of new programing tools or an improved data structure, for example) rather than providing the user with the best possible input/output system for his task. It has been our experience that most users do not care about the system's components that are transparent to them, or their level of refinement and sophistication, as long as they provide the required products within an acceptable timeframe (Love, 1985). As Keen (1976) notes, the user-system interface is not a cosmetic issue to the user; the interface is the system.

As a result, the prototype system to be used (Fig. 2) concentrates on the input/output systems by permitting several iterations (as separate components) before proceeding to link them through a storage system. Physically, the prototype system is being realized

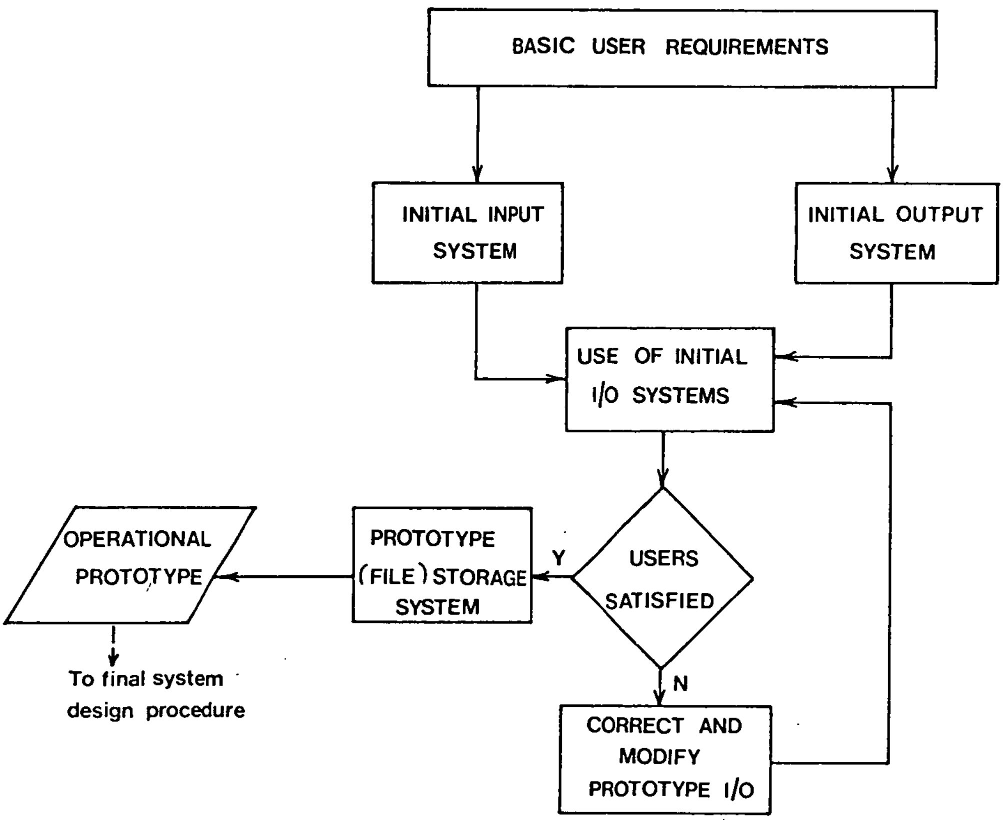

Figure 2. Prototyping as first phase of design.

through a mixture of in-house and packaged software running on microcomputers for the input/output system, with a mainframe connection at the storage stage. Thus the resultant implementation procedure may close the abyss between designers' dreams and users' needs (Humphries, 1985). The use of prototype systems in the design and implementation of land information systems needs to be investigated.

User Needs and Design Considerations for Unstructured Problems

Information systems designed to assist in unstructured problemsolving, especially in the planning and policy process, are characterized by large and diverse sources of heterogeneous data. This data is not necessarily acquired by formal data collection surveys or as by-products of administrative processes. Outputs from these systems are usually nonstandard and the result of an ad hoc request on short notice (Barrett and Masters, 1985). Unlike systems for structure problemsolving, they are designed for decision support rather than decision replacement.

Given this purpose, a number of largely unanswered questions are apparent:

1. How much support could information systems give and for what category of problems?
2. How, and under what circumstances, is the information used?
3. How much and what type of data should the system contain in order to provide the requisite support?
4. How much information and in what form should the system deliver?

These and related questions are a reflection of the complexity of the environment for which systems need to be designed. They are also an indication that the issue is as much, if not more so, a question of how or why the information is used rather than its availability or quantity.

Studies into the likely impact of land information systems in strategic planning and policy analysis have not been extensive. As submitted elsewhere (Zwart, 1984), such efforts are overdue and important for the wellbeing of the land information systems concept. The following discussion focuses on several interrelated issues important in this area.

Admitting new and different information products into the planning/policy phases of decisionmaking represents a change from established procedures. It may, therefore, be helpful to view the use of land information basically as a change process, a topic on which there is a vast literature (e.g., Glaser, 1983; Struening and Guttentag, 1975) " . . . as flimsy as it is substantial, as impressionistic as it is experimental, as narrow, as encompassing, and as academic as it is practical" (Davis, 1973). A number of models of the factors affecting change have been proposed. The better ones, including the A VICTORY model (Davis and Salasin, 1975) which has been applied extensively, serve not only to observe change but also to implement it.

The formulation of an appropriate change model for land information through case studies and the adaptation of models from elsewhere appears to be feasible and may provide an empirical and theoretical background to understand the impact of information in planning and policy decisions concerning land.

Extensive research has been performed on the use and diffusion of knowledge (Glaser, 1983; Havelock, 1969), most of which lends support to understanding the factors affecting the efficacy of land information system products. Other relevant research findings appear in the decision support systems field (Bennett, 1983; Sol, 1983) and in studies of the use of computers in local government (Danziger, 1982; England, 1985). This literature paints a checkered pattern of information use from total rejection (Davis, 1973) for conceptual rather than instructional use (Weiss, 1980) to information manipulation for political justification (Kraemer, 1981).

Similar studies are required to outline the factors influencing the use of land information in, for example, land use planning, land use policy analysis, and monitoring.

Linked to the acceptance of information is its political feasibility (Danziger, 1982) or as Linstone (1984) states " . . . in the political arena highly trained technical information is usually and properly discounted in favor of social interests and considerations and values involved." Social interest, however, is a diverse and volatile quantity that on occasions may be used to advantage. The demand for land information and its use is likely to be maximized when systems can provide information and analysis pertinent to contemporary social and, hence, political concerns. They provide opportunities to have complex concepts (like land information systems) accepted (Zaltman, 1973), raise visiblity, and prove worth. Examples from the recent past of such concerns are conveying costs, foreign ownership, and a range of environmental issues.

Practical, flexible land information systems and design methodologies, able to respond and adapt quickly to new planning and policy initiative, need to be developed.

There is an implicit assumption that the information contained in a land information system is objective, quantified, and correct (i.e., scientific or rational data), which, on presentation, will be used by individuals and organizations who are guided by reason and who are rational according to conventional criteria. Rationality, however, is not an absolute value but a subjective term dependent on the person, the circumstance, and the time. The recognition of the legitimacy of these diverse viewpoints by planners and policy analysts has seen the virtual abandonment of systems models (Breheny, 1984) in favor of multifaceted, multiple-perspective, decisionmaking models (Linstone, 1984). These models not only accept that decisionmaking inherently involves organizations and individuals, they also admit such items as reasonable conjecture, intuition, and assessment of political risk as data, and use dialectic and negotiating processes to arrive at politically survivable but scientifically nonoptimum solutions.

If land information systems are to have an impact on policy, the proponents of land information systems must accept the validity and methodology of other forms of inquiry and decisionmaking besides those based on rational models and attempt to accommodate these by modifying both the substance and form of information produced.

As Stabel (1983) notes,

> ... Decision processes vary a great deal both across the population of decision makers and, for a given decision maker, across decision situations. Systematic and coherent patterns in individual differences are often referred to as cognitive styles. In response to such differences it is frequently proposed that a DSS must be adaptable to a variety of decision processes. However, the argument seldom identifies any limits to the need for adaptation.

Not only does the style of decisionmaking vary, but so do the information requirements. There is evidence to indicate that hard operational type data is used in some situations (Danziger, 1982), while soft nonfactual information such as opinions, explanations, and rumors are required for others (Brooks, 1983). Potential users must perceive that the problem and the relevant knowledge base are in the same information system (Parker, 1975).

The data to be contained in systems for unstructured problemsolving in terms of categories, characteristics, amount, and quality need to be investigated.

Related to the above issue is the need to acknowledge that the data contained within land information systems is neither totally objective nor necessarily based on acceptable statistical measures. Data is classified, filtered, and packaged in discrete units, both temporally and spatially. While codes and standards are promulgated for these operations, their use involves judgment and assumptions which reflect individual sensitivities, blind spots, and emphases. These factors are generally magnified on aggregation to the larger temporal and spatial frameworks favored at policy levels. The use of probabilities and averages may mask individual events and the effects of failure, thus making them unreliable as measures of risks in decisionmaking (Linstone, 1984).

To enhance the use of land information in the policy process, the type, and amount of "statistical" data attached to the information within the system needs to be determined.

Crucial to the issues above is the willingness of the LIM community to widen its horizons, to be weaned from its technologically imperative straightjacket and move toward conceptualizing and constructing user-driven, demand-side systems.

> The potential social benefits of scientific progress cannot be fully realized unless the knowledge is taken up by practitioners (potential users) at the decisionmaking level in government, agriculture,

or industry, or unless those benefits may serve to educate those who, now or in the future, may be expected to influence policy. Ultimately, the meaningfulness of all science, natural and social, rests in the ability and willingness to maintain a responsible dialogue between science and the society that sustains it. [Glaser, 1983]

It is suggested that little dialogue has taken place between LIM practitioners and the wider community it vows to serve, at least not in a language or from a perspective meaningful to them. The need is to vacate our cloisters and deliberately seek to become "role accumulators" or gatekeepers (Glaser, 1983) by establishing both formal and informal links with prospective clients through joining their societies, their invisible colleges, presenting talks and papers slanted toward their problems and couched in their languages.

Summary

This paper has outlined several specific issues which it is believed need consideration and study. Two issues concern the improvements of the design process for systems to solve structured problems and, as such, are very much in the traditional sphere of LIS interests. The other issues, it is suspected, may not be as universally acceptable or deemed worthy of study by all. They are softer, relatively undefined and open-ended issues not likely to produce scientifically verifiable answers. They relate to the interplay among people, organizations, politics, and information (its supply and use). As Smith (quoted by Linstone, 1984) concludes

> What our analysis of the market indicates is that it is useless to attempt to select one orientation, one logic, or one purpose and ignore the others; it indicates that the mind is inherently multi-faceted and any attempt to deny this would only lead to an incomplete picture of whatever subject is being studied.

If it is held that the goal of a land information system is to create and sustain a community resource of information on land, then the system (within bounds) should be amenable to all potential users. To achieve this, application of the LIS concept in the planning and policy decisionmaking process needs to be defined.

REFERENCES

Barrett, S. M. and R. J. Masters (1985), "Information Systems for Policy Planning," in: England, J. R., *op. cit.*

Bennett, J. L. (ed.) (1983), *Building Decision Support Systems*, Reading, Mass.: Addison-Wesley.

Breheny, J. M. (1984), "Policy Implementation and Information—A Review of Changing Roles and Requirements," *Proceedings of URPIS 13*, Wollongong.

Brookes, C. H. P. (1983), "Text Processing as a Tool for DSS Design," in: Sol, H. G. (ed.), *op. cit.*

Calkins, H. W. and R. F. Tomlinson (1977), *Geographic Information Systems, Methods, and Equipment for Land Use Planning*, Ottawa: IGU.

Canning, R. G. (1984), "Fourth Generation Languages and Prototyping," *EDP Analyzer Special Report.*

Danziger, J. N. (1982), *Computers and Politics*, N.Y.: Columbia Univ. Press.

Davis, H. R. (1973), "Change and Innovation," in: Feldman, S. (ed.), *Administration and Mental Health*, Springfield, Ill.: Thomas.

Davis, H. R. and J. E. Salasin (1975), "The Utilization of Evaluation," in: Struening, E. L. and M. Guttentag, *op. cit.*

England, J. R. (ed.) (1985), *Information Systems for Policy Planning in Local Government*, Harlow, Essex: Longman.

Glaser, E. M. (1983), *Putting Knowledge to Use*, San Francisco: Jossey-Bass.

Havelock, R. G. (1969), *Planning for Innovation Through Dissemination and Utilization of Knowledge*, Ann Arbor: Centre for Research Utilization of Scientific Knowledge, Inst. for Social Research, Univ. of Michigan.

Humphries, A. B. (1985), "Property Information Systems," in: England, J. R. (ed.), *op. cit.*

Keen, P. C. (1976), "Computer Systems for Top Managers: A Modest Proposal," *Sloan Management Review*, Vol. 18, No. 1, pp. 1-17.

Kraemer, K. L. (1981), *The Management of Information Systems*, N.Y.: Columbia Univ. Press.

Linstone, M. A. (1984), *Multiple Perspectives for Decision Making*, N.Y.: North-Holland.

Love, W. R. (1985), "A Microcomputer-Based System for Managing Land Information," *The Australian Surveyor*, Vol. 32, No. 7, pp. 523-535.

McCracken, D. D. (1983), "Software in the 80's: Perils and Promises," *Computerworld Extra*, Sept. 17, pp. 5-10.

Palmer, D. and J. D. McLaughlin (1984), "Land Related Information Networks: Assessing User Requirements," *Technical Papers of the 44th Annual Meeting of ACSM*, Washington, pp. 101-110.

Parker, E. B. (1975), "Who Should Control Society's Information Resources," in: Kochen, M., *Information for Action*, N.Y.: Academic Press.

Rittle, M. W. J. and M. W. Webber (1973) "Dilemmas in a General Theory of Planning," *Policy Science*, Vol. 4, pp. 155-169.

Segall, M. J. (1984), "The Use of Prototyping to Aid

Implementation of an On-line System," *Systems Objectives Solutions*, Vol. 4, pp. 141-156.
Sol, H. G. (ed.) (1983), *Process and Tools for Decision Support*, N.Y.: North-Holland.
Stabel, C. B. (1983), "A Decision-Oriented Approach to Building DSS," in: Bennett, J. L., *op. cit.*
Struening, E. L. and M. Guttentag (eds.) (1975), *Handbook of Evaluation Research*,, Beverly Hills: Sage.
Weiss, C. H. (1980), "Knowledge Gap and Decision Accretion," *Knowledge*, Vol. 1, No. 3, pp. 381-404.
Zaltman, G. (ed.) (1973), *Processes and Phenomena of Social Change*, N.Y.: Wiley.
Zwart, P. R. (1982), "A Microcomputer Based Land Information System," *Proceedings of URPIS 10*, Sydney, pp. 48-60.
Zwart, P. R. (1984), "The Rise and Decline of Land Information Systems," *Technical Papers 12th International Cartographic Conference*, Perth. ■

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Chapter 4

PARCEL-BASED LAND INFORMATION SYSTEMS IN PLANNING

P.R. Zwart and I.P. Williamson

A brief overview of this book will show that virtually all software systems designed to assist the process of physical and social infrastructure planning are 'project-orientated' and often attempt to model the 'real world' by drawing on census data or some other small scale aggregation of data. Many of the systems (e.g. most strategic planning and traffic modelling type packages) have to create their own database upon which they then carry out analysis. Other systems, and in particular environmental and natural resource-based systems, sometimes utilise existing digital terrain models, or have to undertake extensive data collection through digitisation or have to utilise remotely sensed data of one form or another.

These project-oriented systems are generally referred to as geographic information systems (GIS). These systems are usually small scale grid-cell-based systems not updated by any ongoing administrative process and are thus not 'dynamic'. Further, the vast majority of these systems have one thing in common; they do not utilise to any great extent the large parcel-based databases found in Land Titles Offices, large utility and statutory authorities, local government, valuation offices and land tax offices (see the following chapter for a proposal to utilise parcel-based data in a planning orientated integrated land information system which includes socio-economic and demographic data). This is understandable considering the enormous amounts of data such systems collect at the parcel level, the difficulty of abstracting planning data from such systems, the problems of integrating data from different systems and the different types of spatial units that may be used in each system. If these difficulties are overcome, this administrative parcel-based data has the potential to be incorporated into, and form the basis for, the development of planning information systems, since the majority of activity in our communities are either based on or related to the land parcel.

THE DEVELOPMENT OF PARCEL-BASED SYSTEMS

The last decade has seen moves to establish state-wide parcel-based land information systems (LIS) in every State and jurisdiction in Australia. The major objective of a LIS is, through a corporate strategy, to manage spatial data by providing linkages between different systems both within and across organisations. This sharing of data can lead to increased efficiencies in managing data, simplified maintenance of data, reduction of duplication, enhanced accuracy of data, the development of new information 'products' and better access to data for decision-makers.

The major developments which have led to the establishment of parcel-based systems are:

(1) the adoption of a strategy in every State or jurisdiction in Australia during the last decade to introduce a land information system;

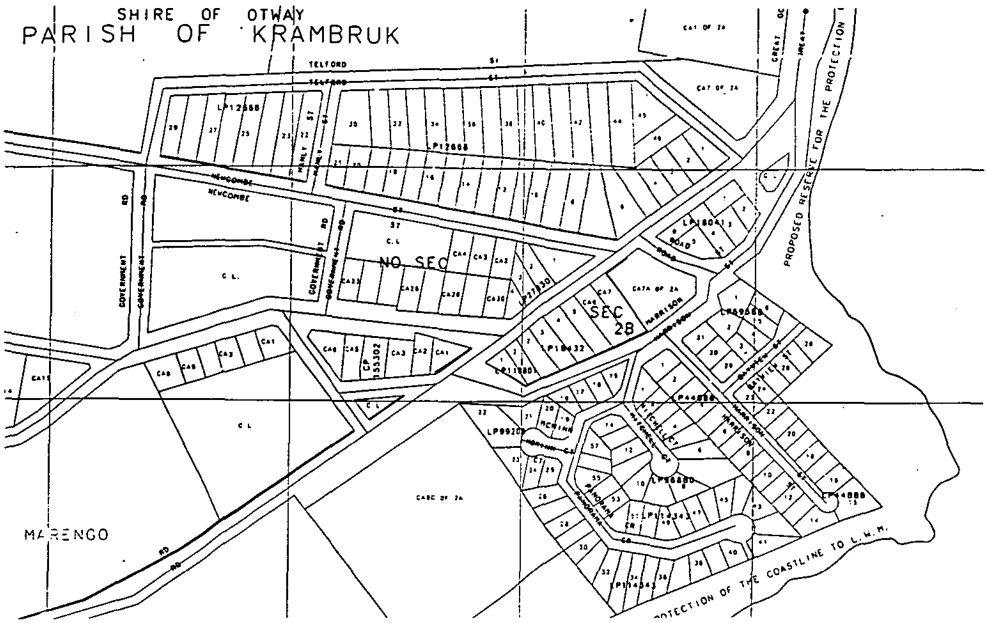

Figure 4.1 Graphical output from a digital cadastral data base

(2) arrangements where the major parcel-based activities such as land titles administration, surveying and mapping, Crown lands administration and valuation are either combined into one government department or coordinated through Land Information Units;
(3) statewide cadastral or parcel mapping programs, at scales of 1:2-4000 in urban areas and 1:10-25 000 in rural areas. These have led in some States to the development of statewide digital cadastral databases (DCDB). See Figure 4.1 for an example of the graphical output from a digital cadastral database;
(4) automation of many of the activities within Land Titles and Valuation Offices.

The systems that have been developed are based on the schematic generalisation given in Figure 4.2. Conceptually they comprise two sets of data describing the characteristics of some spatial or

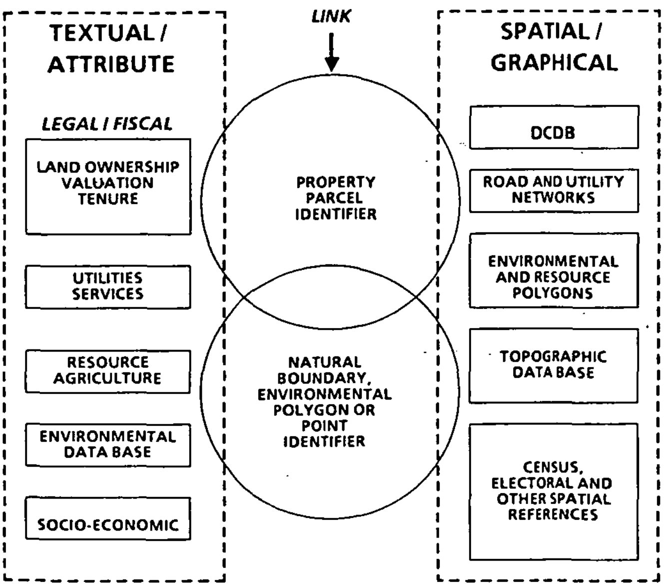

Figure 4.2 Schematic of general LIS concept in Australasia

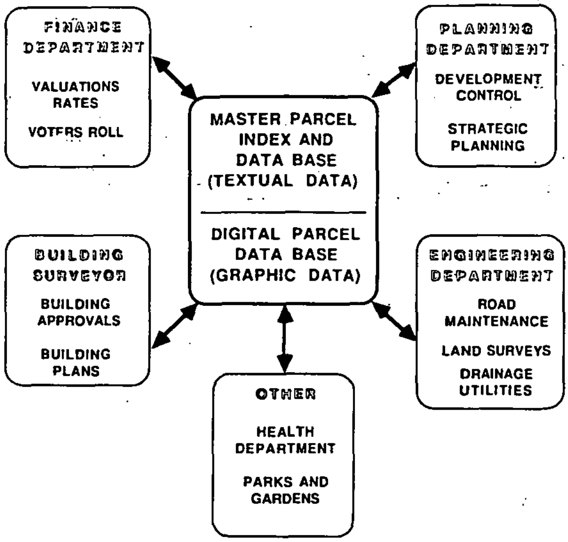

Figure 4.3 Conceptual Model for a Local Government Land Information System

graphical entity. Between these two data sets are a set of two-way pointers or linkages, one in the form of a textual identifier; for example, parcel number, the other a spatial locator, usually a set of geographic coordinates. Both are stored in each data set such that, in operation, the separation of the textual or graphical data becomes transparent to the user; for a more detailed description of the operation of a LIS, see Zwart, 1986, pp.64-76).

At the State level the most advanced systems are to be found in South Australia, Western Australia and Northern Territory (Williamson, 1985). All other States and New Zealand have made significant progress. As a result it is reasonable to predict that most, if not all States, will have operational parcel land information systems in place within the next decade.

The development of these State-based systems is being boosted in some jurisdictions by the activities of large utility organisations; for instance, the Melbourne and Metropolitan Board of Works (Matheson, 1986) who exchange and combine data with other State and local government agencies to form one integrated data set. Similar efforts within the local government arena; for example, the cities of Sydney (Nash, 1986), Townsville (Moll, 1986) and Adelaide (Hanna and Wagner, 1985), based on models such as that illustrated in Figure 4.3, contribute to the formation of comprehensive, reliable and integrated data sets applicable to a wide range of administrative and planning functions.

It should be noted that the definition of what constitutes the 'land parcel' may present difficulties (see Zwart, 1986, p65). Briefly, a 'land parcel' is usually defined as the smallest unit of land which can be legally conveyed. There may be, however, practical difficulties with such a parcel. For example, in the City of Adelaide system there are four relevant 'identifiable' units: the individual Certificate of Title, aggregated 'site' or 'rateable parcel', one or more buildings within each site and within each building the many separable units, each requiring a different identifier (see Hanna and Wagner, 1985). It is therefore important to ascertain which areal unit is being referred to as a parcel.

PARCEL-BASED SYSTEMS AND PLANNING

The importance of the above developments to planning is that within the next decade it seems reasonable to suggest that most States or jurisdictions in Australia will have developed a land information system providing a complete State coverage of up-to-date and accurate information at the parcel level. These systems will include, inter alia, information on ownership, other legal interests in land, land use and development control data, land valuation and land sales. This information will be able to be manipulated, aggregated and displayed spatially, and combined with other socio-economic data such as census data or natural and environmental data to provide more meaningful information for planners and decision-makers. Having a spatial as well as a textual base of information permits, as Hanna and Wagner (1985) note: property references to be enhanced by a visual dimension; visual confirmation of complex property-based enquiries; simplification of searching with spatially defined criteria; aggregation of data based on spatial criteria; graphic representation of textual data; spatially coordinated maintenance of land-related data; standardisation of map and plan bases throughout an organisation, and reduced cost of map and plan production and maintenance. The technical capabilities required to undertake these functions are described below.

COMPUTER SYSTEMS REQUIREMENTS FOR PLANNING FROM PARCEL-BASED INFORMATION

Map Data Handling Capabilities

To simplify the discussion, a distinction will be made between two groups of routines required to transform administrative parcel-based information into data of relevance to planning. These routines are summarised in Table 4.1.

The Refinement and Manipulation Group of routines manipulate data into another form to facilitate handling or analysis by subsequent operators. No analysis is performed – the data is basically made more suitable for futher processing, to improve comparability, facilitate retrievability, and so forth. On many occasions these routines may be all that is required, as the new forms of data can be useful in their own right, or be more readily comprehended visually (e.g. the substitution of symbols for text). Typical data operations include reclassification of both the spatial and attribute data elements on a map, generalisation to produce aggregate spatial data, interpolation processes such as slope/aspect polygons from contours to allow easier visualisation of the data, and scale plus map projection change to allow maps to be fitted together or compared.

The basis on which the data are to be re-ordered may involve the generation of new points, lines or polygons to act as specifiers of location or filters for data retrieval purposes. Systems should, therefore, be able to allow users to define a point about which information is required, or define a line representing, say, a new road location so as to be able to ask further questions about the terrain that it crosses. Similarly, a user should be able to generate polygonal boundaries of a particular area and shape about which to extract further information, be they simple straight side figures or natural or administrative boundaries.

The Data Analysis Group of routines involve the extraction of data from a system for use in a decision-making process. The extraction process may be the simple retrieval of the contents of a file or specified parts of the file or involve complex space-attribute-time queries to such questions as distance apart, size of area, direction, shortest route, nearest neighbour, etc.

Table 4.1. Desirable Data Handling Capabilities

Data Refinement and Manipulation
1 Reclassification of attributes (add, remove, select and join)
2 Coordinate manipulation (shift, rotate, scale change)
3 Projection change
4 Generalise
- Dissolve, merge and eliminate boundaries
- Line thinning
- Line smoothing

5 Generate (points, lines, corridors, regular and irregular polygons)

Data Analysis
1 Overlay

• Point-in-Polygon	)	(Union, join identity,
• Line-in-Polygon	)	intersect, clip)
• Polygon on Polygon	)	

2 Measure
- Count (number of items)
- Distance (between points, along curved lines)
- Areas
- Calculate (arithmetic and boolean conditions)

3 Network Analysis
- Route selection (shortest path, minimum time)
- Allocation (acceptable distance between centres, location of resources).

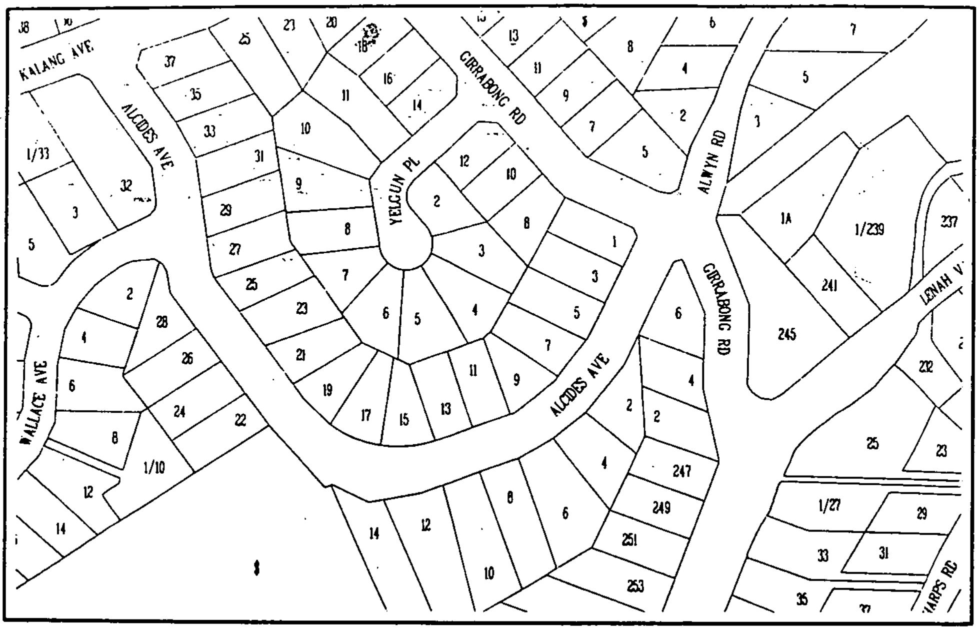

Figure 4.4 Parcel boundaries and identification

The above functions of data manipulation, generation and data extraction may be used to identify optimal conditions, determine suitability for specific purposes and determine conditions which are most desirable for a set of objectives. The nature of the interpretation/analysis may be determined by the user through a 'trial-and-error' process or depend on a set of pre-specified rules or algorithms. Thus the 'best' route between two points, the 'most suitable' land for an industrial estate, the 'most desirable' among several sites for a new park, and similar conditions, can be extracted from the system and evaluated.

DATA MANIPULATION AND ANALYSIS ILLUSTRATED

To indicate how the manipulation and analysis operators function, a section of a pilot parcel-based land information system developed by the School of Surveying at the University of Tasmania for the Hobart City Council will be used. Besides the cadastral database, (DCDB) the pilot also contains information on road pavements, water, stormwater, sewerage networks and building information. For illustration purposes, however, this information is not shown and only the cadastral data are used.

The database of parcel boundaries, parcel identification numbers and street names are illustrated in Figure 4.4 and Table 4.2. The first operation performed is a reclassification of the parcels on the basis of land use instead of identification number (Figure 4.5). This operation changes the attributes used to identify the parcel, and does not require any calculation on the graphical component of the DCDB. A substitution process of this type is usually computationally trivial and fast and may be specified by a set of simple arithmetic or boolean rules.

Table 4.2. Polygon Attribute Table for Figures 4.4 to 4.6

$RECNO	HSE#	ROAD	LUCODE	AREA
2	1	ALWYN RD	LI	4 842
17	36	KALANG AVE	HDR	158
18	38	KALANG AVE	HDR	381
19	11	GIRRABONG RD	LDR	608
21	37	ALCIDES AVE	LDR	670
22	16	GIRRABONG RD	LDR	613

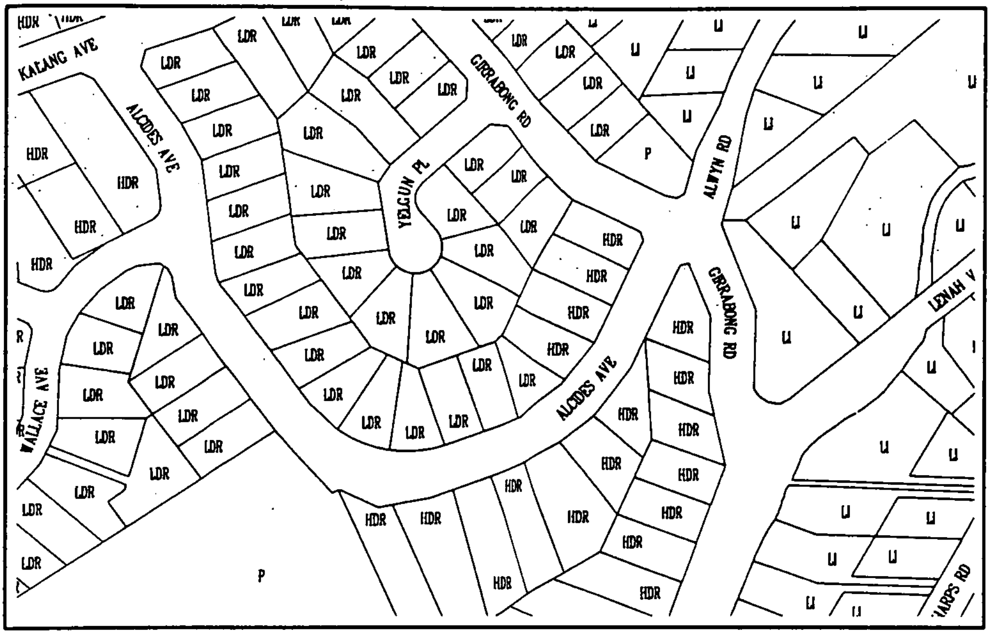

Figure 4.5 Substitution of land use for identification number

The next operation involves generalising the spatial data and attribute data by dissolving redundant internal boundaries and merging the attribute data. The dissolve operation is illustrated in Figure 4.6, while the merge operation (Figure 4.7 and Table 4.3) has aggregated the attribute data on the basis of the new land use polygons. As a result we have now transformed the base map consisting of parcel polygons identified by street address to a land use map wherein land use polygons are

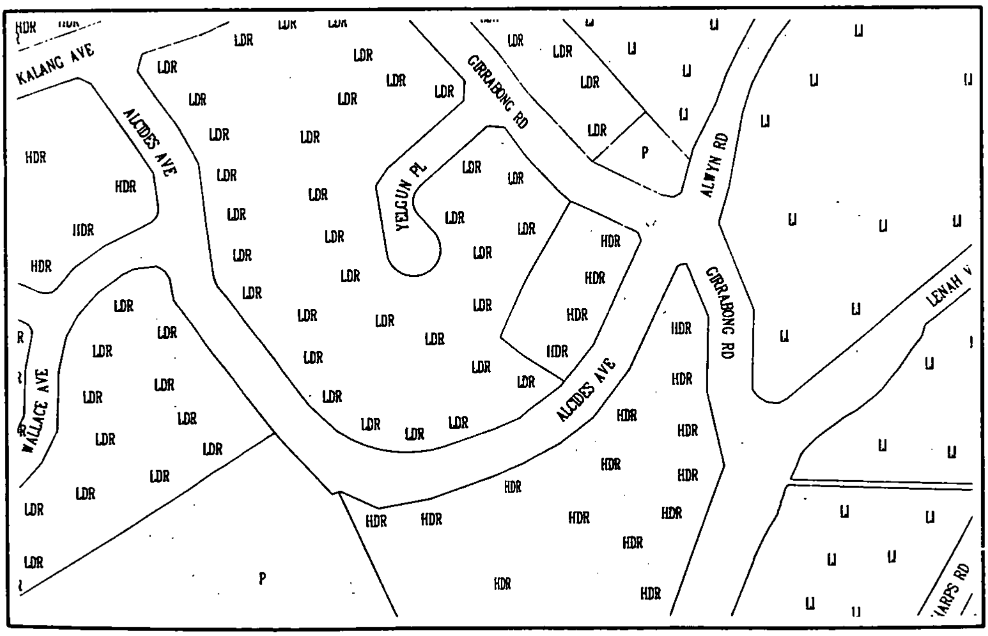

Figure 4.6 Result of dissolving parcel boundaries

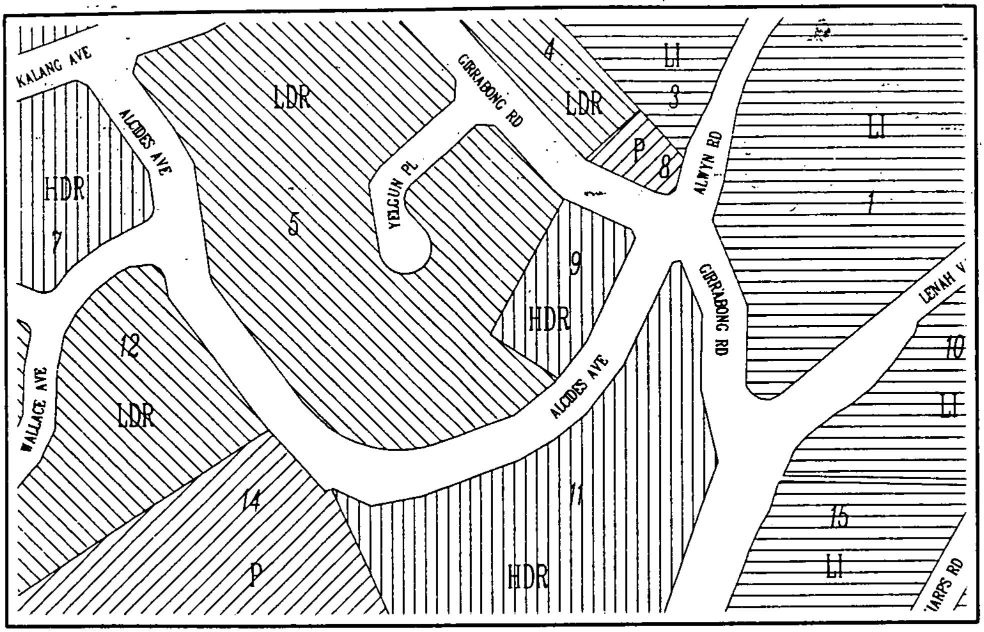

Figure 4.7 Land use polygons

identified. If appropriate, this layer can now be stored and manipulated just like any other data set within the system.

We can now combine the base cadastral coverage and the new land use coverage to select, for example, high density residential land which has an area exceeding 1300 square metres. This could be accomplished in one of two ways.The first and most direct of these is to do a conditional search on area and land use type on the data contained in Table 4.2 and plot the result (Figure 4.8). Alternatively, the areas can be identified by a boolean search on area only and the result overlayed on the land use coverage. In this way the parcels with an area greater than 1300 square metres act as a 'cookie-cutter' on the land use cover, which when combined with a map-join operation, will again produce the map in Figure 4.8 and the attributes in Table 4.4.

A slightly different use of the overlap function is to use various graphical templates to redefine the database. For instance, as illustrated in Figure 4.9, a template of the census collector district (CD) boundaries may be logically defined as a separate overlap which, when superimposed on the cadastral database, can then be used to aggregate, compare and analyse data on a CD basis. Other templates representing such administrative boundaries as wards, postal districts, or such natural features as slope and aspect can also be prepared and used as a sieve to selectively retrieve or

Table 4.3. Polygon Attribute Table for Figure 4.7

$RECNO	LUCODE	AREA
1	LI	17 083
3	LI	3 432
4	LDR	2 676
5	LDR	23 898
7	HDR	5 032
8	P	920
9	HDR	2 783
10	LI	5 505
11	HDR	16 242
12	LDR	8 968
14	P	13 378
15	LI	7 249

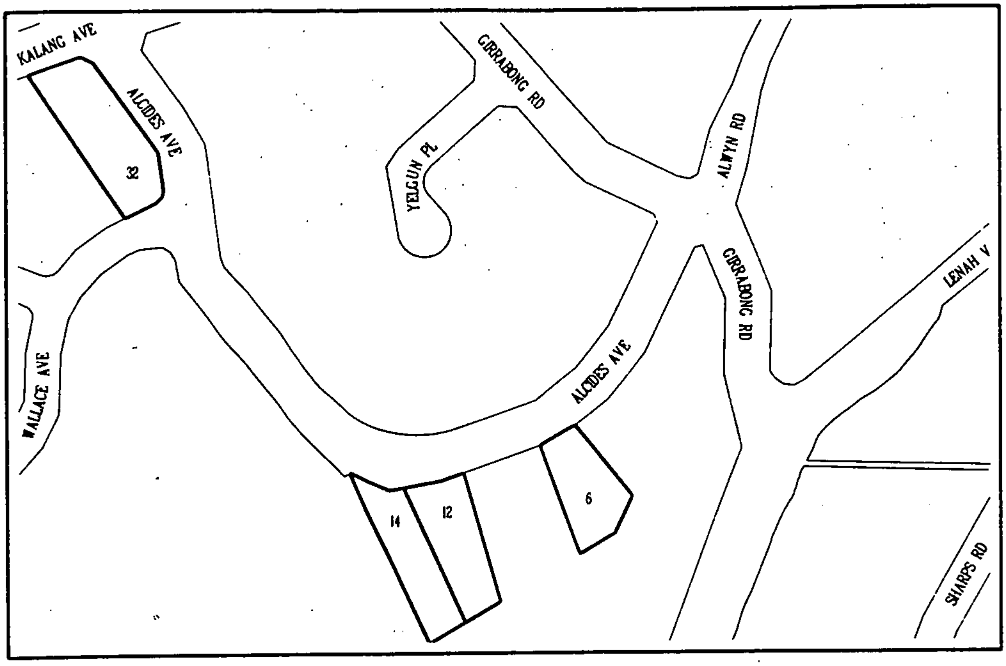

Figure 4.8 High density residential polygons with area greater than 1300 square metres

highlight data. Information within the DCDB may, therefore, be freely restructured to suit a particular user's purpose.

Given the list of operators in Table 4.1, virtually any combination of attribute and graphical data may be reorganised, combined and measured for a range of physical and social planning tasks. While the illustration above has concentrated on physical, spatially-tied data, socio-demographic data such as income, age distribution, occupation, health and so on can equally be related to the DCDB and analysed both spatially and temporally (if data over a number of epochs are available). Further, when the above data handling tools are linked to the appropriate application software, they can fulfil a range of modelling and optimisation tasks, inventory and allocation controls, as well as act as a decision-making aid for planning within and across organisations.

Table 4.4. Polygon Attribute Table

		(LUCODE = HDR AND AREA 1300 sq. M.)		
$RECNO	HSE#	ROAD	LUCODE	AREA
2	32	ALCIDES AVE	HDR	1 945
3	6	ALCIDES AVE	HDR	1 303
4	14	ALCIDES AVE	HDR	1 408
5	12	ALCIDES AVE	HDR	1 438

Table 4.5. Polygon Attribute Table

	Census District Layer	
$RECNO	CENDIS	AREA
2	CD18	21 156
3	CD15	38 239
4	CD12	12 970
5	CD19	21 930
6	CD20	20 315
6	CD14	24 638

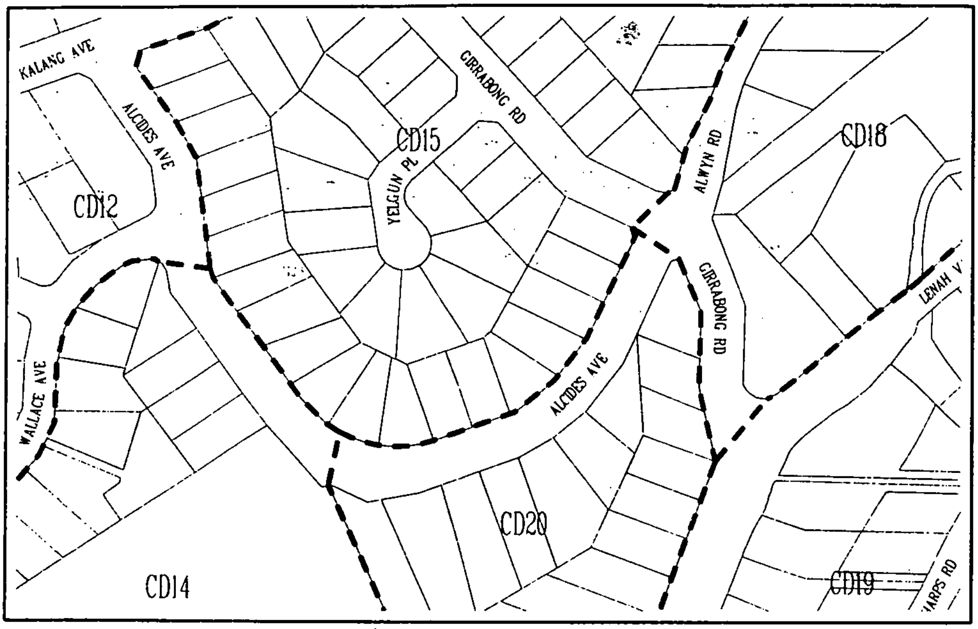

Figure 4.9 Overlay of collector district boundaries

PRESENTLY AVAILABLE SYSTEMS

Until recently, the storage and manipulation of parcel level databases containing spatial and textual information was confined to large mainframe computers. This is still the norm and is likely to remain so in the foreseeable future as the volumes of data are high and many of the analysis tasks computationally intensive.

The first microcomputer-based systems incorporating the features above are now being ported down from their mainframe counterparts. The most comprehensive system available at the time of writing (July 1987) is the PC ARC/INFO product of ESRI, marketed worldwide. It is a complete Geographic Information System with full data entry, data editing, arc and polygon topology, relational database, data manipulation and analysis routines and plotting system. Based on the IBM PC-AT under DOS 3.2, the system, while slow at certain operations (like building topology and overlaying) is more than adequate for small organisations or as an initial step to the introduction of a larger and more extensive system. The basic software costs about $4000 while a complete system (all software modules and hardware including digitiser and pen plotter) may be obtained for about $30,000 – a cost considerably lower than its mainframe counterpart. But, as the latter are usually time-shared systems allowing multiple users, when more than two or three workstations are required, the larger mini-based systems (e.g. MicroVax, Prime) offer distinct performance and cost advantages over the single user microcomputer-based systems. A combination of microcomputer-based systems and a mainframe in a distributed network is, however, an attractive proposition and has been implemented in Victoria by the Conservation, Forests and Lands Department.

Another Australian-developed microcomputer-based system with some of the data handling capabilities described above is available from LAIS (Local Authorities Information Systems, Victoria) – also an IBM PC-based system. There is little doubt, however, that the list will grow rapidly in the next two years as the 32-bit microcomputers come onto the market and the price of the UNIX-based workstations like SUN and APOLLO continue to drop in price. Most of the existing systems have been, or are being, moved to this workstation environment; for example, ARC/INFO, INTERGRAPH, (TIGRIS), CARIS, EAGLE/SIR. Other developments like the CD-ROM, when more common, will all but eliminate the problems associated with large data volumes on small systems. Products like SUPERMAP, developed by Space-Time Research Pty Ltd on CD-ROM linked to a PC to display and manipulate census data, is but a forerunner that will see desktop technology applied to parcel-based information systems.

CONCLUSIONS

Ongoing efforts at both State and local government levels make it likely that comprehensive integrated bodies of parcel-based data will be commonly available in the next ten years. They will be structured in such a manner that other information, based on aggregations of parcels, may be readily added and combined with this database for use in a range of planning applications. As well, developments in technology will ensure that the unit costs of establishing, maintaining and using these systems will continue to reduce in real terms. The same developments will also extend the range of functions and applications that will be possible on desktop machines. Given these developments, the possibilities of using parcel-based information in the planning and development process in a desktop environment should become a common occurrence.

REFERENCES

Hanna, E.J. and Wagner, G.M. (1985) 'The Development of a Land-based Information System for the City of Adelaide', *Proceedings of the 13th Australian Conference on Urban and Regional Planning Information Systems*, Adelaide, 91-109.

Matheson, G. (1986) 'The Implementation of a Facilities Information System within a Major Utility Organisation', *Proceedings of the 14th Australian Conference on Urban and Regional Planning Information Systems*, Melbourne, 104-109.

Moll, A. (1986) 'Integration of Engineering Data into Townsville City Council's Property Data Base', *Proceedings of the 14th Australian Conference on Urban and Regional Planning Information Systems*, Melbourne, 203-225.

Nash, K. (1986) 'The Application of Computers to the Planning Tasks in the City of Sydney', *Australian Planner*, 24(3), 19-23.

Williamson, I.P. (ed.) (1985) *Report of the Working Group on State-wide Parcel-based Land Information Systems in Australasia*, Monograph No. 1, Australian Urban and Regional Information Systems Association, Sydney.

Zwart, P.R. (1986) 'Parcel Based Land Information Systems', in P.W. Newton and M.A.P. Taylor (eds) *Microcomputers for Local Government Planning and Management*, Hargreen, Melbourne.

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SOME OBSERVATIONS ON THE REAL IMPACT OF INTEGRATED LAND INFORMATION SYSTEMS UPON PUBLIC DECISION MAKING IN AUSTRALIA

Abstract: Integrated Land Information Systems in Australia are sufficiently advanced to make some observations on the impact they are having on the quality of public decision making. Criteria to assess this quality are developed and used to evaluate the reported benefits of systems at the State and Local government levels against the rational standards of efficiency and consistency. The identified impacts are summarised and qualified.

INTRODUCTION

> "In type and amount, the data that is concentrated in the government's computers is far beyond anything a single human brain can process. The leaders who use the machines in time of crisis may have no idea why certain forms of information have been collected at all or assigned the weight they carry. Nevertheless, those who sit before the scintillating video screens, stroking keys, calling up authoritative charts and graphs and simulations, are bound to feel briskly in step with the times." Theodore Roszak (15).

Commitments by every State and Territory Government in Australia towards the creation of integrated land information systems for their jurisdiction has reached the stage where the products of some of these systems are becoming available to a wide range of increasingly "information sophisticated" users. Progress with these systems, together with others being established at the Federal level, indicates that by the turn of the century most of the country will be covered by reasonably comprehensive and timely information systems designed to assist in dealing with a range of complex operational and planning problems related to the land.

It also suggests that while the implementation of these systems is by no means yet complete and will require careful nurturing for some years to come, implementation no longer needs to be the dominant concern. Instead, planning has to commence to address a number of post implementation issues including means by which to monitor the effectiveness of our systems to deliver specified information to target users, and to gauge the impact of this information on the task they have in hand.

Most large scale expenditures of public monies in recent years not only stipulate benefit-costs studies to justify starting a new programme, but also call for formal monitoring and evaluation procedures to measure outcomes under operational conditions and establish whether the programme is accomplishing what was intended. As a consequence, a number of well documented methodologies to perform programme evaluation have emerged (e.g. 19), including some in the land information systems field (5,10). There is, however, considerable debate about the effectiveness of the more formal of these procedures (6) and as Wellar (20) notes, they tend to concentrate on measurement and analysis which does not constitute evaluation let alone impact assessment.

This paper uses three qualitative criteria plus their associated standards to judge the impact or otherwise of integrated collections of information on the decision making process. Narrowly, the <u>subject</u> of the assessment is the quality of the decision making, the <u>criteria</u> used to assess this quality is whether the decision process is better or more efficient due to the availability of greater levels of integrated information and the <u>standard</u> against which the quality is to be judged are the (so called) rational ones of consistency, speed, cost and so on. No formal <u>measures</u> of quality are used, nor will any attempt be made to distinguish between or separate out the functional, structural, technical or administrative components contributing to the total impact. For instance, it is a moot point whether such benefits as improved accuracy, retrieval times and currency attributed to land information systems flow chiefly from the fact that the information is in digital form, or are substantially due to the considerable effort expended on reorganising and improving data quality before it enters the data base. As we are concerned with judging the total impact of an integrated <u>system</u> whether one component or another causes the impact is not of concern.

Before any judgements can be made about the real impacts of improved information products on public decision making, we need to define the subject of the investigation (decision making) and the criteria and standards by which these impacts are gauged (consistency and efficiency).

<u>WHAT IS BEING EVALUATED</u>

<u>Decision making</u>

A decision is required when a change occurs to the status quo necessitating the selection of one preferred course of action over another. Prescriptively therefore a problem is posed, this has to be defined as do the alternative actions, consequences and goals to be attained. In many instances in public decision making, however, there is not a consensus of what constitutes the problem, only a series of issues representing a controversy about what requires attention, about the means to be used, and the end to be reached. Policy and planning decisions affecting the quality of life, the environment and distribution of wealth are typical examples of these ill-defined, unstructured problems.

At the opposite end of the decision spectrum are the routine tasks associated with the administration of land, (e.g. title records, zoning compliance certificates etc.) where the problem, the alternatives and the actions are all defined by operational procedures. There is also a third middle group of decisions in the management/planning arena, the so-called semi structured "efficiency" problems, wherein the problem and the goals are defined and accepted but where the means to fulfil these goals need to be optimised. While the boundaries which distinguish these three decision types may at times be blurred, prima facie integrated systems of land information will impact each of these decision types differently.

EVALUATION CRITERIA AND STANDARDS

Criteria of Better

An assessment of the impacts of integrated land information systems on public decision making may be performed using a range of criteria. For the purposes of this paper we use the criteria of better.

The term better is an oft-used but seldom defined phrase in the land information systems literature, and frequently confused with the idea of efficiency.

For something to be better it needs to be an improvement, or more outstanding, or more desirable than some other object or way of doing a thing. Efficiency on the other hand is seen as performing a specific task with a minimum amount of resources - be they time, effort, money or the like. Further, the word better represents a difference between two states, in this case public decision making with or without integrated systems of land information. It is not, however, an absolute term, as better is not the same for all persons, times or places, as few states are unconditionally desirable or undesirable.

Implicitly most technically trained people assume the desired state is that described by the normative or scientific model of rationality, meaning that: human behaviour (decision making) may only be interpreted against some predefined objective or aim; that actions should be consistent over time and that correct rational behaviour can only be measured by systematically relating consequences to objectives.

Better information will, therefore, be interpreted as information that is more reliable, accurate, current, complete and delivered in a more timely manner because an integrated land information system has been created. A better decision will be interpreted as meaning a decision that is more consistent, more rational and more efficient because of the availability of better information.

There are however other norms like the social ones of equity and tradition, the legal view of natural justice and a politician's public accountability criteria. There are also other decision processes based on things like intuition, probability, faith or tradition which admit such items as reasonable conjecture and political risk as data, and employ dialectic or negotiating processes in place of scientific logic to arrive at acceptable rather than optimum solutions. These may be softer, less readily quantified criteria and methods, but they are nevertheless real, and the determinants in many public decision-making processes.

Information Usage

It is also part of the rationalist norm that information, if it is available, will be used in choosing one course of action over another. While this is generally the case in well-defined decision processes, this may not be what happens in the area of policy making or in strategic planning where there is evidence ranging from total information rejection to its manipulation for purely political ends (23). When it is used, information may not necessarily be instrumental in selecting a particular course of action, but rather merely provide a context or a general direction for the final decision. This conceptual use of information is much more common and often must precede instrumental use (13). Instrumental use, however, dominates the thinking of how information is utilized in decision making. If the impact of integrated land information systems on public decision making is to be gauged, then the type of information utilization need to be identified even though the means of determining the conceptual use of information are poorly defined.

Level of Integration

The term integrated land information systems is generally taken to mean that information from a number of functional and administrative domains may be readily combined to produce composite information products to serve the needs of an open ended and largely unknown constituency of users. To reach this point usually involves linking data with unlike identifiers and indices as well as improving data reliability, flexibility and currency.

This level of integration is necessary but not sufficient because as a prerequisite a common language in the form of standard nomenclature, classifications and taxonomies has to be defined. Generally, agreements at this level are much more difficult to conclude as well as maintain, and should, but not always do precede the linking process.

There is also another form of integration, a tenet of the integrated land information concept, namely, that the same corporate data/information will be employed for a range of tasks within and across different levels of decision-making; from the routine to the ad hoc, from administration to policy making. While practically all systems have the mechanical means to achieve this through information transformation and reorganisation routines i.e. spatially (aggregation, overlay etc.), arithmetically or logically, we do not have the tools, or even the knowledge of how to transform information from one user's perspective to another, from one value set to the next, or to communicate it across disparate discipline based cultures and jargons (21). The level of integration that is to be used to measure impact needs therefore to be defined and qualified as part of the assessment procedure.

BACKGROUND TO AUSTRALIAN INTEGRATED LAND INFORMATION SYSTEMS

The most influential level of government in Australia is the State, which administers land allocation and use, land ownership and assessment, fiscal planning as well as public housing, education, health, police and justice. Significant levels of base data integration over large spatial areas can therefore be achieved if a relatively small number of agencies (in the order of 8-12) are willing to co-operate and coordinate their information requirements.

Secondly, the nation's survey and mapping activities have been largely coordinated for the last thirty years through the activity of the National Mapping Council. This has resulted in one geodetic network and one map grid for the entire country, one set of survey/mapping standards and a division of mapping tasks between Federal and State mapping agencies, with the result that a national 1:100 000 topographic mapping programme is now nearing completion. In addition, most States have for the last decade been engaged on large scale mapping (~1:5000) over their urban areas as well as 1:25 000 series over their rural areas. On the whole the availability of base maps is not an issue in establishing land information system in Australia.

Of equal importance is the fact that all States maintain centralised, highly refined public registers of land ownership based on guaranteed Torrens titles, administered by public officials without reference to the courts except in cases of dispute. Where deed registers remain, they are in the process of being converted to the Torrens register, as, in some States, are the registers of Crown Land. Consequently, there are or will shortly be a single authoritative reference source for all land parcels within each State or Territory jurisdiction.

The overwhelming justification for implementing integrated land information systems at both the State and local government level in Australia has been to improve efficiency in dealing with, and using, land related data - and in particular those data sets relating to the individual land parcel. Objectives in each jurisdiction are similar; for example

"- generate administrative efficiency and cost reduction by rationalising the management of basic land records.

- help maximise productivity in public sector agencies through more effective and efficient use of land records.

- improve land-related data availability.....

- increase Government revenue by the marketing of integrated land information....." (1).

These New South Wales objectives are similar for instance to those expressed in West Australia in 1979 as a result of a detailed study of land administration records which highlighted excessively long search times, massive duplication and inconsistencies within and across departmental records.

SOME REAL IMPACTS OF INTEGRATED LAND INFORMATION SYSTEMS

State Level Systems

Efficiency The first integrated land information system (or at least a sizeable component of it) to be operational in Australia was South Australia's LOTS system in 1979. Comprising a central reference file linking title, valuation and land tax data, the system has grown to where it is averaging 11 000-12 000 on-line enquiries per day (16).

Northern Territory commenced a similar system in 1981 while the West Australian Land Information System (WALIS) was able to report in 1985 that: the basic information pertaining to the legal and graphical cadastres were within the system; that the majority of the 1979 reports recommendations had been fulfilled and that "production and revenue gains (were) achieved within organisations such as Lands and Surveys, Office of Titles, State Taxation, State Energy Commission and Town Planning....." (8). The other States are anticipating like results from their implementations.

No formal quantitative impact assessments have been undertaken for any of these systems. Importantly, however, these integrated systems are perceived to be efficient, cost effective and the "gains represent only the tip of the iceberg when compared with the amount of information retrieval which occurs annually in the manual system" (8). Even if at some later date their cost effectiveness was to be called to question, most systems have passed the critical point in terms of the amount and range of data captured, ensuring that user support will sustain their existence. As Moore (12) notes, the demand for improved productivity in the public sector is not a passing phase and as a consequence, the pursuit of savings will need to remain the first priority of land information systems managers.

Better Decisions The impact of the Australian integrated land information systems are, however, extending beyond the narrow domain of business-like efficiency and are beginning to deliver some of the other predicted benefits. For example, in the more advanced States the level of integration is such that routinely, agencies are starting to exchange and combine data to produce a range of information products that were previously technically impossible or cost effectively prohibitive (16). This new type of information enables more alternatives to be examined and increases the likelihood "that accurate decisions will be made" (21).

In another example, Simpson (17), reporting on the environmentally sensitive Flinders Ranges confirms, as has happened elsewhere, that the use of publicly available value-neutral data bases, reduced the number of contentious issues in the public decision making process thereby enabling governments and lobbyists "to focus on those issues and in those areas in which conflicts between land uses are real rather than apparent". As a flow on, policies emerge that are based on the same criteria and couched in a "common language". Interestingly, common ground is usually reached because the data bases can and do incorporate, manipulate and graphically display such scientifically intangible values as scenery, wilderness, remoteness, recreation and so forth (9). While protagonists may not agree on the relative importance or weight attached to each in a particular land use issue, the ability of systems to portray and if necessary replicate these values on an understood and agreed basis removes these potentially divisive items from the debate.

Acceptance of this common ground rests, however, on the neutrality and credibility of the data incorporated in the model of the real world being represented by the system. If, as is more generally the case (2) neither the model nor the data base are intrinsically value free, then it would be wrong, and unsupported by the evidence to suggest that integrated land information systems can impact all, or most public decision making through issue reduction. In fact, as Moore (12) states when referring to strategic policy, "there does seem to be some serious difficulties to overcome before rational policy setting based on information systems even approaches reality except in limited and specialised applications." With few, if any exceptions, the reported applications of integrated land information systems, including the examples cited above, fall within this specialist category, i.e. lower level policy and planning judgements representing closed loop decision systems with defined (but not necessarily few) alternatives. Information and the ability to systematically transform it may be the crucial and decisive ingredient at this level of decision making, but as both Annells (2) and Moore (12) contend, it is not information but expertise that is required in the political and strategic policy arena.

They view expertise to include not only knowledge, experience and political awareness, but the ability to respond to requests for professional advice in rapidly changing, data deficient environments by establishing credibility "in their [the politicians] eyes, and by their values" (2). In this context reliable, unbiased objective data may only provide an insurance policy - an insurance policy that the subjective, value laden interpretation of the issues being projected by the advisor is not caught out through factual inadequacies. Regrettable as it may seem, and in keeping with the experience in other fields of administration, the impact of better information products from formal information systems on decision making at the upper echelons of government by themselves is at best only conceptual, highly selective and largely unpredictable. There is, however, evidence (13,16,17) to indicate that the impact of better information on policy formulation may be greater than proposed by Annells and Moore once the decision making chain becomes less traditional, less hierarchical, and autocratic and begins to use processes such as group participation, heuristic learning and group consensus building to make a choice.

Integration Turning now to the question of integration, the observations above are confined to systems that have been "mechanically" integrated by linkages through common data items. Usually this has been successful because the component systems have been at the same level of administration as well as within the same jurisdiction. Problems relating to relevance, language and values encountered in transporting information from one level of government to another are therefore avoided. There is little or no evidence to suggest that 'vertical integration' of data use is occurring within the State agencies. There is evidence, however, that the same information is being used for multiple purposes within the same tiers, e.g. initially for planning, and subsequently for implementation and monitoring (17). Thus the same data that is used to determine land capability contributes to land use planning and serves to monitor land use compliance as part of the land management operation.

Clearly, while multiple use of the same data creates efficiencies, the main impact integrated systems are having in this regard is due to their superior formal data management capability in terms of data organisation and data consistency, through their algorithm based manipulation and analysis functions. Methods and criteria used to develop specific information products are therefore defined and repeatable. They avoid having random unaccountable differences occurring in investigations and "inconsistencies and discrepancies in data that stem from, if not the same, then closely allied sources" (3) impinging on integrity. Again, in the cases of well defined decision cycles, the availability of an integrated, common data base is creating efficiencies and providing a more consistent and reliable basis for making decisions.

Systems at the local level

Most of the findings identified above are applicable to the systems that have been established in the local government sector and by utility agencies. For them the integration of data is normally purely an internal affair, within a corporate identity and a corporate mission to achieve agency-wide efficiencies. Systems like those in the cities of Sydney, Brisbane, Townsville and Adelaide were in the main established to "improve level of service, reduce risk of error arising from duplicate records, quicker response to enquiries and reduce staff pressures" (7). The resultant corporate data bases are being used for a wide range of activities from planning to the issuing of tax demands to bus route mapping.

Once again it appears that no formal assessment of these systems has taken place, but reports in the literature suggest that the impacts are impressive:

"The resultant data base not only increases operation efficiency but also proves a comprehensive tool for decision making" (7).

"There have been significant costs involved.....however, the benefits of an accurate, comprehensive and centralised data base are equally significant" (18).

The reported benefits of facility information systems that have been installed by a number of utility and engineering authorities are similar:

"The SECV's (State Electricity Commision of Victoria) application of such a system has been fully justified and easily meets the Commission's economic evaluation criteria" (4).

"The capture of the Board's map base information in digital form introduces the many advantages associated with digital mapping technology and will improve the service to the public....." (11).

Once more the emphasis in these systems is on improving efficiency and the quality of decision making where the goals to be achieved are defined and the process to reach them bound.

SUMMARY

There is little doubt that the integrated land information systems established in Australia are having a qualified but none the less positive impact on public decision making throughout the country. While the evidence for this is mainly anecdotal rather than formal and quantified, it is based on the reported experiences of a large number of system implementations to serve a diverse range of users. This evidence suggests a number of concluding observations.

(i) The stress is on improving operational efficiency at the routine level of decision making at the parcel level through improved location and retrieval of individual data items achieved by rectifying data, their indices and linkages to other data sets. Positive operation efficiencies are being made in such operations as title searching, boundary location, valuation (assessment), addressing and in the speed of delivering this information to users.

(ii) Cleaning up the data and its organisation is ipso facto providing more consistent, reliable, comprehensive i.e. better information, which is being used to choose between alternative solutions in task like rural land use planning, urban planning schemes, power distribution networks etc. The reported impacts in these closed loop, "goal-oriented" tasks are positive.

(iii) Better information products from integrated land information systems in themselves are making little instrumental impact on the decisions made at the higher policy level. This situation is likely to continue until:

(a) they are coupled with expertise in presenting professional advice at this level of government, and

(b) the policy setting environment permits a range of decision making styles wherein, for example, the data base is used interactively to gain understanding and consensus building. Hence, the decision making process may be more influential in selecting the preferred course of action than the quality of information on which it is based.

(iv) It follows from (b) above that better information will have its maximum impact in the policy arena when agreed value judgements and non-rational data items are incorporated in the data base and admitted to the decision process. There is evidence not only in Australia (13) that this is happening.

(v) Integrated data bases are being used for multiple purposes, i.e. planning, implementation and monitoring at or near the same operational level for which the original data base was established. This usage of the information system represents an efficiency gain at the data output end of the system, in contrast with the gains identified in (i) above that are obtained primarily at the data entry stage.

Somewhat surprising, given the large amounts of public money that have been invested in integrated land information systems in Australia, there appears to have been no formal evaluation of their performance. While in the course of planning system development, some land information systems have been reviewed (e.g. in South Australia, Western Australia) these studies seem neither to compare systems implementation with systems justification nor methodically quantify systems benefits. There are a sufficient number of mature systems in Australia for studies of this kind to take place.

Also unexpectedly, there appears to be a dearth of applications using the real time decision making capabilities of integrated land information systems for modelling and optimization in such tasks as route selection, vehicle despatching, power loads, flood level control, etc. Prescriptively, these "efficiency problems" where goals and alternatives are quantified and the full analytical capabilities of systems may be brought to bear, promise to yield the maximum possible impacts (24). For the models to be realistic, however, requires detailed, up to date data found at the local level. That few of these systems have been implemented in Australia, as opposed to North America, perhaps reflects the comparative development of integrated land information systems at the State and Local Government levels in each country.

The full benefits of integrated land information systems at the local level in Australia are yet to be realised, but in the meanwhile it is evident that in a number of States integrated land information systems are producing more consistent, reliable and comprehensive information products which are starting to positively impact a number of public decision making processes.

REFERENCES

(1) Alexander, Elizabeth and Hart, Anthony L. "Communicating With Decision-Makers," Australasian Urban and Regional Information Systems Association Proceedings URPIS 15, 7.2-16 to 7.2-22 (1987).

(2) Annells, Bob "Information and Professional Advice in Government", Australasian Urban and Regional Information Systems Association, Proceedings URPIS 15, 1-2 to 1-8 (1987).

(3) Beecroft, David "The Planning Office, or, How not to Store Information", Australian Urban and Regional Information Systems Association, Proceedings URPIS 14, 112-128 (1986).

(4) Chenco, A.C. and Davis, B.W. "Electricity Distribution Management", Australian Urban and Regional Information Systems Association, Proceedings URPIS 14, 196-202 (1986).

(5) Clapp, James L., McLaughlin, John D., Sullivan, Jerome G. and Vonderohe, Alan P. "Toward a Method for the Evaluation of Multipurpose Land Information Systems", Urban and Regional Information Systems Association, Proceedings, Volume I, 1-10 (1985).

(6) Glaser, Edward M., Abelson, Harold H. and Garrison, Kathleen N. "Putting Knowledge to Use", San Francisco, Jossey-Bass Publishers (1983).

(7) Hanna E. John and Wagner, Geoffrey M. "The Development of a Land Based Informatoin System for the City of Adelaide", Australian Urban and Regional Information Systems Association, Proceedings URPIS 13, 91-109 (1985).

(8) Hyde, Ian "The Western Australian Land Information System - Where has it Been and Where is it Going?" Australian Urban and Regional Information Systems Association Proceedings URPIS 13 55-63 (1985).

(9) Ingles, Andrew and Woods, Michael "The Use of an Automated Geographic Information System in Land Use Planning for Crown Forests in Tasmania", Australasian Urban and Regional Information Systems Association, Proceedings URPIS 15, 4.2-30 to 4.2-48 (1987).

(10) Levine, Myrne S. "Use of Program Information System for Evaluation: Case Study of the Utilization of NCHS - National Family Planning Patient Data System for Program Performance Evaluation," Urban and Regional Information Systems Association 1975 Proceedings, Volume I, 274-283 (1975).

(11) Mathieson, Garry "The Implementation of a Facilities Information System within a Major Utility Organisation", Australasian Urban and Regional Information Systems Association, Proceedings URPIS 14, 104-109 (1986).

(12) Moore, Dennis "Information Systems, Policy Setting and Planning", Australasian Urban and Regional Information Systems Association, Proceedings URPIS 15, 3-2 to 3-12 (1987).

(13) Niemann, Ben J. "Better Information for Better Decisions: No Question About It", Australasian Urban and Regional Information Systems Association, Proceedings URPIS 15, 10-1 to 10-14 (1987).

(14) Pelz, Donald C. Utilization of Environmental Knowledge on Northern Michigan. Final Report: Centre for Research on Utilization of Scientific Knowledge, University of Michigan, Ann Arbor (1977).

(15) Roszak, Theodore "The Cult of Information", Cambridge, Lutterworth Press, 1986.

(16) Sedunary, Merv. E. "LIS Development in South Australia - 1987 Status Report," Australasian Urban and Regional Information Systems Association, Proceedings URPIS 15, 4.3-7 to 4.3-16 (1987).

(17) Simpson, Paul "The Flinders Ranges Management Review: A Case Study in Interactive Data Base and Policy Development", Australasian Urban and Regional Information Systems Association, Proceedings URPIS 15, 4.2-2 to 4.2-19 (1987).

(18) Stasiukynas, Allan "Shoalhaven City Council's Property Information Management System", Australian Urban and Regional Information Systems Association, Proceedings URPIS 12, 6C-1 to 6C-18 (1984).

(19) Struening, E.L. and Guttentag, M. Handbook of Evaluation Research, Beverly Hills, Sage, 1975.

(20) Wellar, Barry S. "Evaluation of Information Systems: Beyond Concerns of Measurement and Analysis to Impact Assessment," Australian Urban and Regional Information Systems Association Proceedings URPIS 9, (1981).

(21) Weshe, Jenny "The Crown Land Study", Australian Urban and Regional Information Systems Association, Proceedings URPIS 14, 174-178 (1986).

(22) Zwart, Peter R. "The Production of Information for Policy Decisions from Land Information Systems," Invited Paper, Commission 3 XVIII FIG Conference, Toronto, 322-331 (1986).

(23) Zwart, Peter R. "User Requirements in Land Information System Design - Some Research Issues," Surveying and Mapping, 46, 2, 123-130 (1986).

(24) Zwart, Peter R. "Better Information for Better Decisions: Fact, Fiction or Maybe", Australian Urban and Regional Information Systems Association, Proceedings URPIS 14, 38-46 (1986).

EMBODIED GIS - A CONCEPT FOR GIS DIFFUSION

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ABSTRACT. Our most widely used processes are those that provide background services for the completion of some desired task. Such enabling technologies tend to go largely unrecognised and therefore all but disappear from view; they become embodied in the task. This chapter proposes some conditions for GIS to attain a similar status. These are compared with prevailing GIS products. Suggestions on how GIS may change into a ready-to-hand embodied technology are made.

1. Introduction

To be accepted, an innovation needs to adapt to the requirements and situations of its potential adopters. That is, successful diffusion implies as a precondition that the users of an innovation have a major say in its form, its functions and the environment in which it resides. If the innovation is responsive to its users, then, as some of our more profound technologies (like the wheel, or writing) have demonstrated, the innovation may be so highly successful as to become integral to its user community. Under such conditions it will tend to disappear - it will no longer be recognised as a discrete technology, but rather become part of the everyday life of its users. These diffused technologies lose their separate identities and requirements for specific recognition. They become background, enabling technologies, unnoticed, and embodied in other tasks and processes.

It is suggested that this too should be the objective of the GIS community - to embed GIS into everyday life until it is indistinguishable from it - until people fail to recognise it as a separate technology. This chapter is an initial exploration of this notion; it outlines some of the conditions necessary to achieve embodiment, and compares this with where we are today. The supporting empirical data are derived from two projects at the Centre for Spatial Information Studies at the University of Tasmania. The first is an annual survey of the sales characteristics by major GIS and desktop mapping vendors in Australia (Figure 1). The second dataset is derived from GIS workspace logs, at the individual command level from three organisations collected as part of a GIS network study reported in Zwart and Coleman [1992]. The data in Figures 2 and 3 is from one of these organisations, the Tasmanian Forestry Commission, a near mature ARC/INFO GIS for forest planning, operations and management.

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2. Embodied GIS

Whenever a technology "disappears" it is fundamentally as a consequence of human psychology and learning rather than as some particular trait of the technology itself. Essentially, if we learn something sufficiently well, we cease to be aware of it, we no longer consciously invoke the technology; it becomes a background, enabling technology. The German philosopher, Heidegger, calls this "ready to hand technology", in a sense transparent "... in my ordinary dealings ... I 'see through it' to the work that has to be completed" [Guignon 1983]. A ready to hand entity becomes a means of doing something within a hierarchy of predetermined goals and purpose. Thus, if our goal is to communicate the ideas contained in this book to people other than the authors, the ready to hand technology of books has to be available. Importantly, few of us <u>understand</u> or have even <u>thought</u> about how this book has been produced and manufactured. We merely wish to <u>use</u> the technology to communicate our ideas. For our higher purpose of communicating, the technology of the book has disappeared from our thoughts, it has become embodied in the process of communicating by the written word.

Embodied GIS is an analogous concept. Our aims should be to diffuse GIS to such an extent that it is incorporated into, and subsumed by, the particular task at hand. While a GIS has to be present to complete the task, the fact that a GIS is being used should be a totally transparent, unrecognised and unconscious event. What is acknowledged at all times, however, are the produce of the GIS; what disappears are the means, the GIS technology of its production.

There appear to be a number of conditions which need to be satisfied to make GIS such an enabling technology. Some of these are evident from the work of Weiser [1991] and his colleagues at Xerox in their attempt to bring about what they term ubiquitous computing, "... the idea of integrating computers seamlessly into the world at large". To achieve this, they believe a number of conditions need to be satisfied.

1. Computers will need to be invisible, in fact as well as in metaphor. They will therefore need to be small, so that they can be embedded in other devices. As well they will need to be available in a variety of sizes and forms to suit a range of individual tasks from the complex to the simple. Contemporary examples are microprocessors in watches, microwave ovens, and light switches.

2. Each component part will be dedicated to execute a specific or limited, well defined range of operations common to everyday life, as well as more esoteric tasks.

3. Unlike today's computing devices, components of a ubiquitous computing system will not be "owned" by any one individual or remain fixed in any one location. The system components "are intended to be 'scrap computers' (analogous to scrap paper) that can be grabbed and used anywhere; they have no individual identity or importance". Computers will therefore need to know where they are, where in a wired or wireless network they are located at any given time, in order for them to recognise the user and the user them, as both must be allowed to move around freely.

4. The real power of a concept does not come from any one type of device, but from the interaction between all of them.

The vision of ubiquitous computing is diametrically opposed to the concept of virtual reality. The latter attempts to simulate the world in a computer - the computer becomes the focus, whereas ubiquitous computing attempts to invisibly enhance the real world. Some of Weiser's colleagues therefore use the term "embodied virtuality" to distinguish it from virtual reality indicating that ubiquitous computing is designed to "bring the 'virtuality' of computer readable data - all the different ways in which they can be altered, processed and analysed" out into the physical world, "out of their electronic shells".

Weiser believes that ubiquitous computing will gradually emerge as the dominant mode of computer access over the next 20 years. Given Xerox's track record of pioneering major computer developments (like the Xerox Star - the precursor to graphic user interfaces and object oriented constructs) this prediction should be taken seriously. There therefore seems to be a reasonable probability that at least significant elements of ubiquitous computing concept will be available as a means of fulfilling the parallel notion of embodied GIS.

The work on ubiquitous computing provides some empirical ideas on how the concept of embodied GIS could be implemented. It suggests that, *inter alia*, the conditions for embodied GIS are:

1. In the majority of cases the operation, technology and products of the GIS will provide a background service only. To do this it will need to be totally subjugated to, and subsumed by, the task or process to which it is coupled.

2. There will be a number of kinds of GIS differing in size, form and function, with most dedicated to performing only a limited but well defined set of operations on limited and defined types of data.

3. They will be ubiquitous, having multifarious users, none of whom has a proprietary or usage right to, or necessarily understands the operations of a particular embodied GIS device.

4. They will be affordable and not noticeably different in cost to other support role technologies.

Undoubtedly these initial conditions for embodied GIS will prove to be neither sufficient nor complete, or appear to be particularly profound. But like the embodied virtuality concept, no new revolutions in either hardware or software are required, nor will its realisation produce anything fundamentally new. Rather it will help to make GIS fit into the human environment, make it an unconscious part of every day life instead of attempting to mould humans to it. Some possibilities on how this may eventuate will be the subject of the following discussion.

3. Present Day GIS

From an embodied GIS point of view, the present state of GIS technology may be characterised as follows. Firstly, as the 1991 GIS World software survey [GIS World 1991] indicates, the number of systems on offer continues to expand, reflecting an increasing and more diverse market for GIS products. A close examination of the types of software on offer in Australia supports the trend evident in other countries (Figure 1) towards an increasing market share, at least numerically, by systems with less than full spatial analysis capabilities - the so-called desktop mapping systems. In general these systems employ simple data structures, limited and more intuitive functionality leading to simpler command structures and user interfaces plus lower system costs.

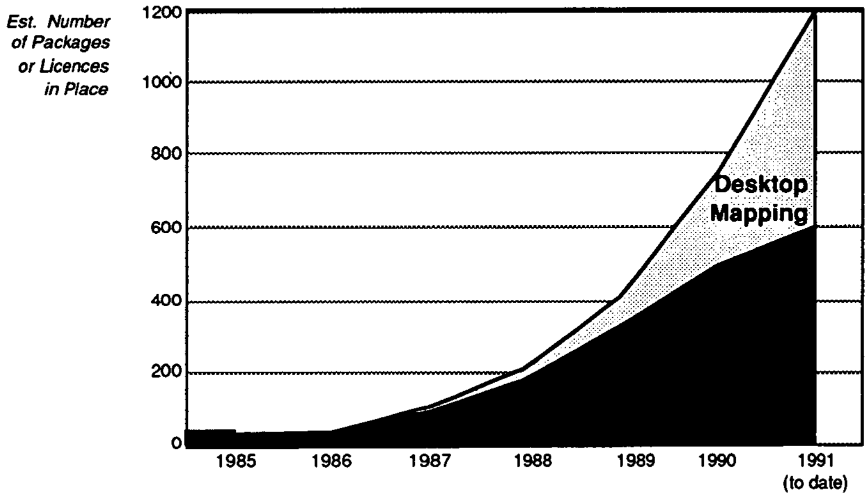
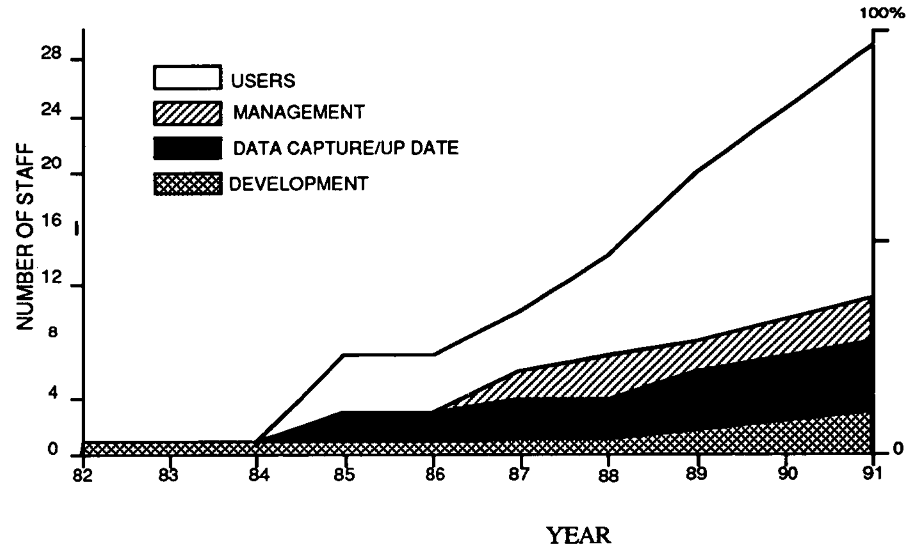


Figure 1. GIS and Desktop Mapping In Australia 1985-1991
(Estimates Based on Figures Supplied by Selected Software Vendors in Australia)

Secondly, there is an emerging trend towards systems being directed to particular market/user segments based on functionality and use, e.g. TRANSCAD for transport planning, TACTICIAN for retail marketing. Whereas conventional GIS software does, or at least strives towards providing functions to satisfy most conceivable query, mapping and analytical needs - to be all things to all men - many of the desktop mapping systems are now designed to target specific niche markets. These products, and desktop mapping systems in general, are one of the main contributors to GIS gaining acceptance as a tool with application well beyond the "traditional" land based professions in the wider community of general economic, social and community planning, management and operations. As Dangermond [1991] notes, and the sale of desktop mapping systems supports, the growth of these commercial GIS applications "in the decade ahead will dwarf the developments of the past".

Closely related to the market success of the desktop systems is the growing stock of digital data on a wide range of topics available on conditions that makes their use comparatively attractive and simple. This not only applies in the socio-economic arena, but also in the land based agencies where many systems are now reaching maturity in terms of data and application development.

The availability of near complete data sets is in turn changing the way most GIS systems are used. Not only will end users (as opposed to systems developers or system managers) begin to dominate (Figure 2), the functions the system needs to perform will also be inclined to change, and are in fact becoming more selective and restrictive. To illustrate this point, Figure 3 represents three months averages of ARC/INFO commands invoked by a system manager and a systems user. They show that not only are the commands that each group uses different, but so are their variety and range. End users tend to use fewer commands, mainly for textual queries and display with little or no use of spatial operators. Full details of these user characteristics may be found in Coleman and Zwart [1992]. These user characteristics, together with the functionality built into most desktop systems and products like ARCVIEW or GENABROWSE, support the notion of offering GIS with limited options, designed to fulfil specific tasks for a given purpose.



(Source: Tasmanian Forestry Commission)

Figure 2. Changing User Patterns

In summary, GIS is moving away from its initial base in the landed sciences, where location is the major determinant, to a less cohesive, heterogeneous range of applications where location may be just another factor for consideration. With an increasing consolidation of data bases and their contents becoming more readily available, the use to which data are put and the number of people using them may be expected to grow. There is evidence, however, to suggest that these users may be satisfied with relatively simple tools to undertake comparatively well-defined tasks on straightforward and simple systems.

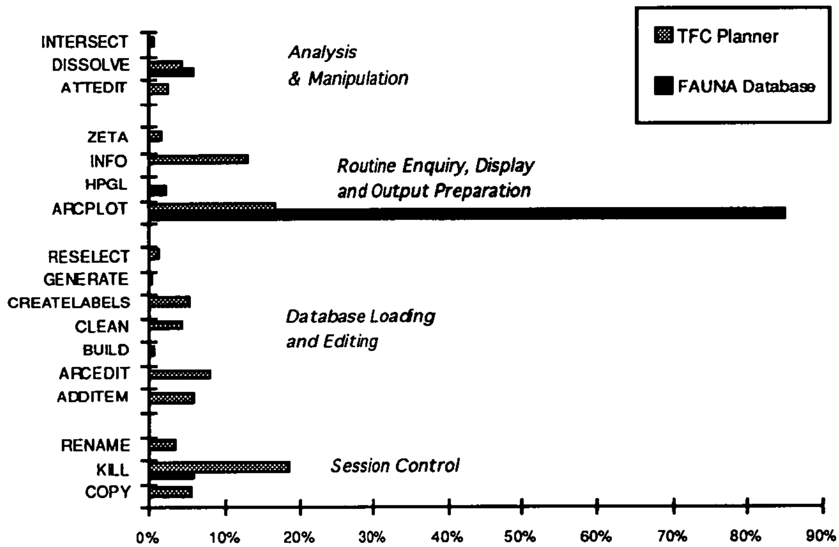


Figure 3 Comparative Summary of ARC/INFO GIS Usage
TFC Forest Planner and Routine Database Enquiries

4. Towards Embodied GIS

If we compare current conditions with those proposed to make GIS an everyday, ready-to-hand technology, it appears that some underlying conceptual, if not physical changes in the way we perceive, implement and use GIS may be required. The key change is the transformation of GIS, within the bounds of a particular application, into a subservient background technology as opposed to the foreground stand-apart technological profile so commonly adopted today. Some ways of facilitating this change are proposed below.

4.1 BACKGROUND GIS

To date the GIS community has taken great pains to differentiate GIS from the rest of information technology by emphasising its unique ability to store and manipulate data in the spatial domain. It is this difference that is stressed by GIS cognoscente when promoting the advantages of their technology and its potential applications. Their deliberate emphasis on GIS spatial prowess creates the perception that GIS is a distinctly different technology; sets it apart from other information systems, heightens its exotic nature and thereby reduces its everyday acceptance.

It is true that GIS is a different information technology - but not so different. What is required to make GIS an everyday tool is to emphasise its similarity with other data base and information technologies, to highlight its commonality; to indicate how it may fit seamlessly and transparently with existing information systems and applications. The extra functionality that GIS offers may then be described as an addition to, not as something separate from, present day computing.

The required shift in emphasis called for is more cultural than physical; a change that would also bring the GIS community to more fully integrate with the overall information science community, thereby helping to break down the artificial, intellectual and disciplinary barriers that are unnecessarily growing up and restricting the development of GIS in many areas. Systems like SIRO-DBMS [Abel 1989], and experimental systems which provide spatial extension to standard data base models and operations, as well as the increasing interest being shown in spatial data bases by computer scientists [e.g. Guenther and Buchman 1990] are positive signs in this direction.

A more significant change, however, will need to take place at the application level. In future, as the analysis of user profiles in Coleman and Zwart [1992] indicates, it is likely that - proportionally - less and less *ad hoc* use of GIS systems will take place - their use will tend to become a mainstream, rather than an exotic activity, close-linked, and an integral part of the routine business fabric. In this environment GIS will then begin to operate within the confines of systems and processes external to itself, be they vehicle despatch systems, forest planning or urban infrastructure maintenance programmes. It will be these activities which determine what is produced and how it is produced; the GIS will merely become the component part that handles and processes the spatial phenomena. Under these conditions GIS functionality and operations would all but disappear, tend to lose their separate identity and requirement for specific recognition. This in turn implies a change of creed, a change in the belief by hoist organisations and the GIS community in general that GIS is a stand-alone and different technology to one that explicitly acknowledges its role as a complementary but subjugate tool, embodied with in some larger system. There is evidence to suggest that this is already occurring in organisations with near mature GIS [Zwart 1992].

At the operational level, bringing about a reduction in GIS as a distinct technology may require, amongst others, geography to be conceived and implemented as an attribute of thematic data rather than the theme being an attribute of its spatial entity. Most spatially intelligent GIS packages today automatically reflect changes in the spatial domain with corresponding changes in the textual domain. Emphasis on text as opposed to space implies that changes in the textual domain should be automatically reflected in the spatial domain - quite a different approach and one for which few theories are available. Given, however, that in an embodied GIS environment such operations would be tightly constrained and defined by their subsuming technology and its goals, operators of this kind appear to be - at least *prima facie* - possible. An acceptance of this notion would imply considerable change or extensions to most current software.

There are a number of reasons for proposing such a 'text before space' concept, the principal one, as discussed earlier and illustrated by Figures 1 and 3, being that geography in general and spatial analysis based primarily on adjacency and connectivity in particular are not, paradoxically, items of major concern to many GIS users. Future generations may require more extensive spatial operators, but until they have achieved an everyday standing, their incorporation as an embodied tool is unlikely to reap many benefits. In the meantime, geographical operations, of even the simplest type, tend not to be familiar or everyday skills. Current GIS software requires users to identify spatial entities such as areas and arcs and select the spatial operators they require to complete the task at hand. If GIS is to become a ready-to-hand technology, then such spatial operations need to become transparent and background tasks triggered largely unknowingly by the user through an operation with which he is familiar. In short, what is proposed is that users be unaware of the geographic operations occurring in the background, but the results of which they may display on request.

4.2 DEDICATED GIS

One of the suggested conditions for converting GIS to a ready-to-hand technology, is its availability in a variety of guises, dedicated to performing specific tasks on specified types of data. A number of present day GIS' are already moving in this direction as noted above.

With GIS data sets maturing, and experience in their use accumulating, it will be possible to define more and more operational and management tasks. What was an *ad hoc* operation may well become routine as the organisation and users adjust to daily dealing with GIS. Consequently, it will become practical to tightly define, and separately programme, the GIS operations associated with an increasing number of everyday tasks. Embodying specific GIS operations within a range of routine tasks therefore seems desirable and distinctly possible.

To effect this, however, simplified and reduced GIS instruction sets, and in particular straightforward system interfaces, are needed. Reduced GIS functionality like those employed in desktop mapping systems with extensive use of window technology are only part of the way to achieving readiness-to-hand status. We need to reach a point similar to that illustrated by Winograd and Flores [1986, p164], where, like while driving a car you do not think about how far to turn the steering wheel to round a corner.

> "In fact, you are not even aware (unless something intrudes) of using a steering wheel. Phenomenologically, you are driving down the road, not operating controls. The long evolution of the design of automobiles has lead to this readiness-to-hand."

Similarly a successful embedded GIS device should also allow a user to operate on spatial data displayed on the screen, or from within a coupled task, without explicitly being aware of formulating or issuing a GIS command. The users should remain in the flow of their work and not be disrupted by the spatial or mapping process unless it is the work on which they are engaged.

Creating systems of this kind is a general problem, not one unique to GIS, and already is being addressed by groups like Weiser's [1991]. Reducing geographical operations to the level of unconsciousness is, however, very much a task for the GIS community, one which perhaps may necessitate a different approach. For example, since tasks and functions in embodied GIS will need to be definable, it may be fruitful to investigate how systems functionality could be improved through alternatives like incorporating spatial intelligence to the way the data is organised and structured [Driessen and Zwart 1989].

Secondly, even though there are signs that GIS vendors are starting to develop more specialised products for specific applications, there are few signs to indicate a move away from utilising general purpose CPU's processing software encoded GIS functionals. GIS specific hardware, or firmware to perform embodied GIS functions and processes are still a long way from realisation. But, as the diffusion of GIS to date has resulted as much, if not more, from the supply of appropriate software and data rather than one of demand [Brown 1981], the shortfall of hardware and software for embodied GIS technology is perhaps not surprising. With more digital data becoming available, the pressure to exploit this resource may lead through demand side pressures to more specialised systems. Given the vitality and number of players in the GIS software market, it seems unlikely that opportunities of this kind will long remain unrecognised.

4.3 UNRESTRICTED GIS

Assuming GIS does become an integral, unobserved background means of achieving some pre-determined objective, one further condition to achieve every day familiarity seems necessary; within the context of the task, and as far as the user is concerned, it must become a free commodity or service. When we buy a computer we buy it complete. The purchaser is not concerned about where the components came from, how they are licensed, or the conditions applying to resale. Unless we are interested in computer manufacturing, all the technical details of the system and their workings are of little concern.

If GIS is to become part of some larger system, a similar approach should be adopted. Hence, in embodied GIS, GIS vendors will supply components to be coupled with others to make up some new system. The GIS component parts (in either soft, firm or hardware form) may consist in some instances of just spatial functions and operators, or in other cases bundled products comprising both function and data. Where data is widely used, such as census boundaries and census attributes, the bundled approach, together with simple I/O and system interfaces, would seem an appropriate method to embed census spatial operators into business and marketing decision systems, for example. In other instances, complete systems as we know them today may be incorporated as a component of some larger system, such as environmental monitoring decision support systems.

Superficially perhaps these conditions do not appear to differ greatly from moves towards value adding and software integration being offered by a number of today's suppliers. They differ significantly, however, in their starting point.

The component (embodied) philosophy takes it for granted that GIS is not an end in itself. It is assumed that it operates within the confines of systems and processes external to itself, and that it will be these outside processes that specify the GIS task functions.

This also means that, just like other enabling technologies (the book, steering wheel and computers), the user will be disinclined to want to understand, consider or consciously recognise the component parts making up the system. For all practical purposes they will have disappeared from view.

5. Summary

This chapter has advanced the idea that for GIS to obtain an everyday acceptance it will need to diffuse to such an extent that it disappears, recedes from conscious view as a separate technology. To achieve this level of diffusion, it is further proposed that GIS needs to be transformed into a ready-to-hand technology, embodied and unnoticed inside some higher level task or process. A preliminary formulation of the conditions required to attain these ends where also given.

As the overview of present day systems trends showed, it appears that in some ways GIS is already moving tentatively in this direction, and thus critics may argue that the concept of embodied GIS contributes little except to formalise, with hindsight, what is already taking place. Such a view, however, misses the central idea of embodied GIS, namely, the diffusion of the technology will only be complete when those in the community gaining advantage from its use, know it so well that they stop being aware of it; when they unknowingly use it in their daily activities merely as a means to an end. Bringing this about implies a change of creed, a change in the belief that GIS is a stand alone and different technology to one that explicitly acknowledges its role as a complementary but subjugate tool.

This has, and with few exceptions will always be the role of GIS; an enriching enabling technology by which to gain insight into geographical phenomena and processes to assist in arriving at some desired outcome. The concept of embodied GIS is an attempt to explicate and highlight this role and thereby possibly providing an alternative framework and perspective on how GIS could, or even should, diffuse.

6. References

Abel, D.J. (1989) SIRO-DBMS: A Database Toolkit for Geographic Information Systems, *International Journal of Geographical Information Systems* 3(2): 103-115.

Brown, L.A. (1981) *Innovation Diffusion*, Methuen, London.

Coleman, D.J. and Zwart, P.R. (1992) Modelling Usage and Telecommunication Performance in Real Time Spatial Information Networks. *Proceedings 5th International Symposium on Spatial Data Handling* 144-153.

Dangermond, J. (1991) Commercial GIS will be Driven by Diverse Applications, *International GIS Sourcebook*, GIS World, Fort Collins.

Driessen R.J. and Zwart, P.R. (1989) A Model for Representing Cultural Parcels in a GIS. *Proceedings of URPIS 17*, Australasian Urban and Regional Information Systems Association, 443-451.

GIS World (1991) *International GIS Sourcebook*, Fort Collins.

Guenther, O. and Buchman, A. (1990) Research Issues in Spatial Databases, *Data Engineering* 13(4): 35-42.

Guignon, C.B. (1983) *Heidegger and the Problem of Knowledge*, Hackett Publishing, Indianapolis.

Weiser, M. (1991) The Computer for the 21st Century, *Scientific American* 265(3): 66-75.

Winograd, T. and Flores, F. (1986) *Understanding Computers and Cognition*, Ablex Publishing, New Jersey.

Zwart, P.R. and Coleman, D.J. (1992) *Trade-Offs towards Real Time Spatial Information Networks*. In Newton, P.W., Zwart, P.R. and Cavill, M. *Networking Spatial Information Systems*, Bellhaven, London.

Zwart, P.R. (1992) Mature GIS - or Taking the G out of GIS. *Proceedings of SIRC '92 Colloquium*, University of Otago, New Zealand.